SCIENTIFIC AMERICAN SUPPLEMENT No. 109

Scientific American Supplement, Vol. V, No. 109.
Scientific American, established 1845.

NEW YORK, FEBRUARY 2, 1878.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

## A NOVEL METHOD OF FORMING JOINTS IN GAS AND WATER MAINS—A LEAD JOINT CALKED BY HYDROSTATIC PRESSURE.

IN Nos. 62, 64, 66, 67, 68, and 69 of the SUPPLEMENT may be found a series of articles, extracted from the *Journal of Gas Lighting*, upon "Pipes for Gas and Other Purposes." These articles include nearly every form of joint now in use, or that has been suggested, that has any pretension to practicability or value; and the conclusion to be reached—not only from their perusal, but from an acquaintance with modern practice as well—is that the old method with the open "spigot" joint and calked gasket of lead, as described on page 1048, SUPPLEMENT No. 66, is, everything considered, to be preferred to any one of the more recent devices which has made its appearance previous to that which is the subject of this article.

The conditions to be provided for in successfully joining sections of mains which are to be subjected to internal fluid pressure, whether liquid or gaseous, are principally as follows: That such joints shall be tight, and so remain, unaffected by disturbing causes such as the changes of dimension, both longitudinally and diametrically, due to changes of temperature, and in the former case the necessary end motion of the one section within the other, or by deflection of the mains from a right line from settling of the ground or other causes; integrity of the material forming the joint under long-continued contact with the fluid contents of the mains, or with substances which are deposited within them after continued use, as in the case of coal or other illuminating gas, and economy in the preparation and completion of the joint. To these may be added the comparatively minor considerations, facility of repair, from which no structure whatever can be expected to have absolute immunity; the least possible obstruction to public use the streets or places where the mains may be in process of laying or repair; possibility of an easy and quick disconnection of the joint whenever it may become necessary; facility of perfectly joining mains in places difficult of access, or where water is present in the trenches; the performing of all operations involved in the forming or perfecting the joint *in situ* with comparatively deflection, a large mass of lead is uselessly consumed. Without doubt, therefore, the correct theory, and the one upon which the new joint is based, is that the joint shall yield to deflection from settling of the ground or other cause, *and still remain tight.*

At about the center of the internal depth of the bell a groove is cast, slightly dovetailed in shape, as shown. In this groove—and at the factory before taking the mains to where they are to be laid—a ring of lead is cast, flush with the inner surface of the bell, as in Fig. 1, and upon one side of the bell a threaded hole is made, leading to the groove, containing the leaden ring. A clearance of about $\frac{1}{16}$ of an inch is allowed between the spigot and bell; and in this condition the sections are laid in position, one after another, as the trench is prepared.

The threaded hole is always placed uppermost when the section is laid in the trench, and, when properly entered, a semi-fluid substance—preferably thick tar—is forced in through the threaded hole by means of a suitable instrument—a simple "jack"—attached directly to the threaded hole. The effect of this is that the tar or other substance used finds its way around between the outer circumference of the lead ring and the bottom of the groove, the lead being forced in toward the spigot, and the tapering form of the groove insures that the semi-fluid forcing material does not escape by the sides of the ring into the interior of the bell. The lead ring is in this way made to flow down and partially out of the groove, is brought into close and forcible contact with the spigot—the hydrostatic pressure upon it being very great—and a part of it spreads out wider than the groove itself, forming a kind of head—like a rivet-head, as it were—assuming the form shown in Fig. 2, and effectually preventing the lead gasket from being forced back into the groove by any subsequent disturbance of the joint. A threaded plug is inserted in the hole upon the removal of the forcing "jack," thus completing the joint.

The cuts show the sections joined concentrically; this is immaterial, however, for practically the spigot rests upon the gasket at the bottom of the bell when entered, and the joint is equally perfect when formed with the parts in that position. It will be observed that the face of the lead gasket plied to deflect the sections even to a considerable angle, the joint remains perfectly tight, the gasket being the only point of contact with the spigot end, and its pressure upon it being materially increased by such deflection. The actual enlargement of the internal diameter of the gasket under such circumstances takes place not by its being forced back into the groove, but by the lateral spreading of that portion of it unconfined by the groove.

The advantages of this new method of sealing pipe-joints over that acknowledged to be the best and the one which is almost universally resorted to, the ordinary calked lead joints, are many, and of the greatest importance; and while some of the numerous devices hitherto suggested possess features superior to the calked joint, as a whole, they are every one inferior.

In England the turned and bored joint has lately been used to some extent, and is strongly recommended in the extract from the *Journal of Gas Lighting*, in SUPPLEMENT No 67, p. 1060; and a saving in cost is attempted to be shown in a paper before the British Association of Gas Managers; but upon a full consideration of all the "ifs" and "buts," it is quite plain that this plan possesses elements which puts it out of favorable comparison even with the calked joint.

There was on exhibition at the Centennial a pipe joint which appeared to be in some respects superior to the bored and turned joint, but, like it, possessed the fatal feature of inflexibility; and flexibility seems to be a *sine qua non* in a perfect joint: that is, an ability to conform to either accidental or purposed deviations from its original alignment, without leakage or fracture. It may therefore be concluded that, previous to the appearance of the new "hydrostatic" joint, the calked joint was, everything considered, the best; and it remains only to compare the new one with it, as a whole, to establish its superiority over all that has gone before.

As to the important point of yielding to deflection without fracture or leakage, it seems to be as nearly perfect as can be desired. It will be seen by the cuts that ample space exists between the bell and the spigot for the two sections to make a very considerable angle with each other without

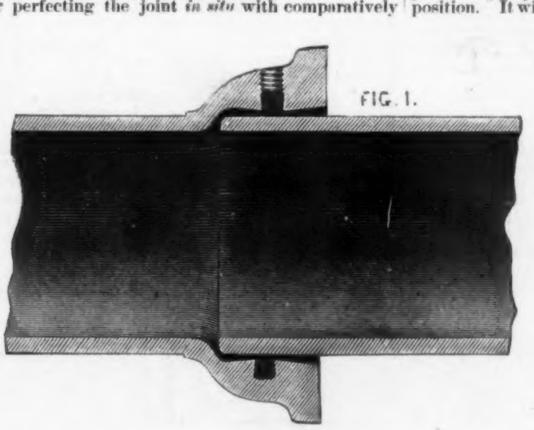


FIG. 1.

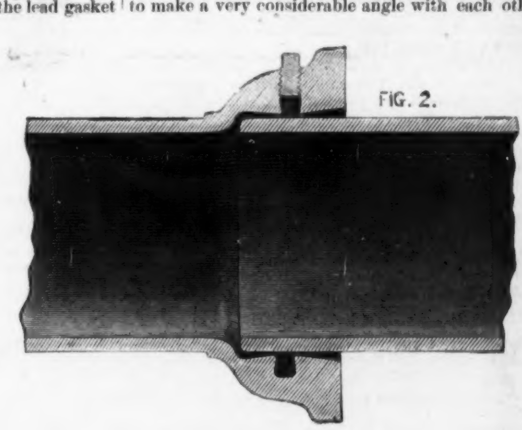


FIG. 2.

THE HYDROSTATIC JOINT FOR GAS AND WATER MAINS.

unskilled labor; a minimum of material expended in the process; applicability to all sizes of pipes and varieties of fittings, and the occupation of a minimum of time in the operation.

A joint which will embody all these points may well be pronounced a desideratum; and a careful consideration of the character of this new joint, together with the tests to which it has been subjected, will convince engineers, I think, that in every one of them it fills the bill.

Like many other most important inventions, it is simplicity itself, and this is no small recommendation; for a very large number of ingenious and most welcome conceptions of the inventor soon after trial pass into oblivion because of their complexity and the mechanical difficulties encountered in their practical use and application. This feature of the new joint will commend itself at a glance in comparison with any or all of the others alluded to.

In principle it is essentially *a lead joint, calked by hydrostatic pressure.* This novel and eminently practical method, aside from its great economy, retains all that is of value in the ordinary calked joint, and introduces many new and valuable features and advantages hereafter to be referred to. In the cuts, Fig. 1 shows the joint with the parts in position before completion, and Fig. 2 the completed joint. In general form the spigot and bell are much the same as with the ordinary calked joint, except that the bell is somewhat shorter and smaller in diameter, and the spigot is devoid of the usual bead. The interior of the bell is also beveled or tapered somewhat in both directions, as shown in the cuts, to allow of the sections being laid at a considerable angle with one another when required, or to permit of their being deflected from a right line, when so laid, by the sinking of the supporting earth, or by accident, without injury to the joint or leakage as a result.

It is well known that deflection of mains must take place, as the forces acting upon them are practically irresistible; and it is equally well known that leakage of the ordinary calked joint is the inevitable result. In the vain effort to make such joints sufficiently rigid to resist the tendency to is concave, Fig. 1, to insure a more perfect joint, particularly in gas mains; this concavity being filled with red lead and oil or other soft packing before the mains are connected. This is an important advantage, and one which cannot be availed of in the common calked joint.

It is not to be understood that the integrity of this joint is dependent upon a maintained pressure upon the back of the lead ring, as it is quite well understood that it is practically impossible to maintain a high pressure for any considerable time under such circumstances. In the making of this joint, therefore, the forcing "jack" is removed as soon as the lead ring has been forced to its proper contact with the spigot, and thus the hydrostatic pressure upon the lead gasket is entirely removed. It might be thought at first sight that a mere narrow ring of lead, as used in this joint, without any sustained pressure behind it, would yield upon the first mechanical disturbance of the joint, but this is not the case. It must be remembered that in the operation of calking the ordinary joint but a very small fraction of the depth of the lead gasket is really brought under the influence of the calking tool, and that, therefore, a very similar narrow ring only, having by no means so equably distributed a pressure upon the spigot, is really in forcible contact with the latter; and while there is absolutely no maintained fluid pressure upon the exterior of the lead ring after the joint has been completed, there is, nevertheless, always a practically unyielding substance behind it which cannot escape or become lessened in volume by lapse of time; the lead gasket is, therefore, in as favorable a condition to resist being forced back into the groove as though the entire groove was filled with lead, and more so, as the confined forcing material is a less compressible substance than would be the same thickness of lead.

Experiment proves, however, that even with the plug removed, or never inserted, no force that can practically be brought to bear upon it can drive the gasket back into the groove, because of its being enlarged or upset by the enormous hydrostatic pressure upon it in the act of forming the joint, as previously described. When sufficient force is ap- contact, the gasket forming a kind of fulcrum upon which the motion may take place. The effect of such action upon the gasket—which is quite narrow in proportion to the total length of the bell—is to compress and still further tighten it upon the spigot, as will be readily understood. In some recent experiments a deflection of 9 inches in a 6-inch main, 12 feet long, caused no leakage; it would appear, therefore, to be impossible for leakage to result from forced deflection after the perfection of the joint.

With the ordinary calked joint it is well known that even a trifling deflection results in leakage, from the fact that, in the operation of calking, as in all similar operations akin to riveting, the lead is more forcibly pressed upon the spigot at the outer edge of the gasket, where the calking tool impinges, and that the pressure becomes less from that surface toward the bottom of the bell, that portion of the gasket in close contact being probably less than half an inch wide. In the forcible deflection of such a joint, therefore, it will be readily seen that the thin zone of greatest pressure of the gasket will be disturbed by a slight deflection, and as the opposite side at a further distance within the bell is not under equal strain, the spigot leaves the gasket on the side opposite the disturbing pressure, immediately where the calking was perfected, without a compensating pressure occurring at a point further within the bell, and leakage is the result. Of course this new joint can be formed with equal facility with the sections, making a considerable angle with one another, thus readily accommodating itself to exigencies unprepared for in the original plan of laying the mains. This is an important advantage.

In making the ordinary calked joint a fibrous gasket must be calked in the bottom of the bell to prevent the lead from escaping into the interior of the mains when poured, and a dam of clay is formed around the mouth of the bell. Then the calking operation is a tedious and laborious one, and the work often quite defective, particularly on the under side, where, unless a very deep depression is made in the trench at this point, the difficulty attending the opera-

tion causes the workmen to neglect it. And in any event, the trench must be made considerably larger at this point to permit of the operations being successfully prosecuted.

The quantity of lead consumed is over three times what is necessary for the new joint, and, instead of all these numerous operations, very few are required. The trench need not be nearly so large, while the sections may be placed in position with equal facility; and there is nothing more to do than to connect the jack to the bell and inject the semi-fluid material behind the gasket until the required pressure is reached, as indicated by a suitable gauge attached. The forcing jack is now disconnected and the screw plug inserted in the bell, completing the joint. The whole operation requires but a few minutes, even with a large main.

In cost of labor there is a disparity of not less than 10 to 1 in the two kinds of joints, while the hemp-packing and dam, as well as the usual cumbrous melting appliances, are dispensed with.

The following figures show that the lead required for the new joint is less than one-third that necessary for the ordinary calked joint, as stated above:

| ORDINARY CALKED JOINT. | | NEW "HYDROSTATIC" JOINT. |
|---|---|---|
| Diam. | Lead in lbs. | Lead in lbs. |
| 2 | 1¾ | ⅞ |
| 3 | 2¾ | 1¼ |
| 4 | 4 | 1¾ |
| 6 | 7 | 2½ |
| 8 | 10½ | 3½ |
| 10 | 14½ | 4¼ |
| 12 | 19½ | 5 |
| 16 | 28½ | 6¾ |
| 18 | 32½ | 9½ |
| 20 | 35½ | 10¾ |
| 24 | 48 | 12½ |

A mean of these weights gives for the old joint 18.59 lbs., and for the new 5.33, making the ratio 3.48, or nearly 3½ to one.

It would be difficult to imagine anything of the kind more easily repaired in case of breakage from extraordinary causes than this new joint. In such case it is only necessary to make a small opening in the street, immediately above the joint, connect the forcing jack, renew the pressure, and restore the plug. Mains may also be disconnected, or plugs removed for attaching other mains or branches with great facility, by wrenching the parts in such a way as to spread and slightly enlarge the internal diameter of the gasket, when, there being no bead upon the spigot end, it is easily withdrawn, and the joint is readily re-formed by simply renewing the hydrostatic pressure with the jack, as in the first instance. Plugs or caps may also be removed, and other fittings or mains connected in the same manner, without the necessity of renewing the gasket.

A very strong prejudice is entertained by some engineers against any kind of pipe joint that will not permit of the ordinary calked joint being made upon it as a *dernier ressort;* and although it was no part of the inventor's design to provide for this, the joint will commend itself to all such as insist upon this precautionary feature; for the space from the lead gasket to the end of the bell may be filled and calked when desired, and without the preliminary operation of filling in the bottom of the chamber with the usual fibrous gasket.

The facility with which this joint may be made in positions difficult of access, or under water, is no small recommendation, the top of the main only having to be reached to connect and disconnect the forcing jack and to insert the plug.

It may be laid in trenches only large enough to receive the mains, no enlargement at the joint being required; while its capacity to conform to required deviations in direction renders it possible to place mains joined in this way in almost any conceivable situation.

All the work of laying mains with this kind of joint may be done successfully by unskilled labor, all that is required in forming and perfecting it being the application of sufficient power to the forcing jack, the hydrostatic pressure distributing itself uniformly upon the gasket. Little opportunity is afforded, therefore, for making other than perfect joints.

It will be observed that the lead gasket is inclosed and firmly seated in its groove; hence no possible pressure within the main can dislodge it—an important advantage in mains subjected to great or sudden pressure, as in the Holly system of water works.

The "hydrostatic" joint has been tested under a water pressure of 1,000 lbs. per square inch without leakage, and it will undoubtedly stand any pressure that the mains themselves will endure.

Aside from the question of labor saving, the brief time required to form the joint in laying the main, or in repairing it in case of necessity, causes much less than the usual obstruction to thoroughfares. It is applicable to all sizes of mains and all kinds of fittings. It will require no explanation to show that, for subaqueous operations, such as the laying of pipe lines across river beds, the operations to be performed in the perfection of this joint are the essence of simplicity compared with any of the others shown.

The only part of the formation of this joint requiring skill in the operation is the casting of the ring of lead in the groove of the bell; and this is done at the foundry, and may be said to constitute a part of the manufacture of the mains. To insure solidity and freedom from "blow-holes," "cold-shuts," and other defects in the lead gasket, a simple and effective method is adopted. An expanding ring of metal is placed in the bell, covering the groove, its edges being luted with clay. This ring has a hole in its bottom side, through which the lead is poured, or rather forced in, under pressure, by a suitable appliance, while hot and liquid; the lead filling the bottom of the groove first, rising and displacing the air, which escapes through several small channels cut across the threads of a temporary plug, screwed into the threaded hole in the top of the bell. These small channels permit of the escape of the air, but not of the lead, which immediately chills on reaching them; and after the groove has in this way become filled with lead—its escape at the plug being prevented—considerable pressure is maintained by the forcing appliance until it has solidified throughout, when the removal of the temporary plug cuts off the small threads of lead, which filled the grooves in it, provided for the escape of the air, leaving the hole clear for the injection of the tar. This method of casting the lead gasket in the bell is rapid, and the result is all that could be desired.

The new joint has already been subjected to all necessary and severe tests all of which go to establish its adaptability to encounter successfully every exigency that arises in this branch of engineering, and it cannot fail to be of great interest and value in this extensive industrial specialty.

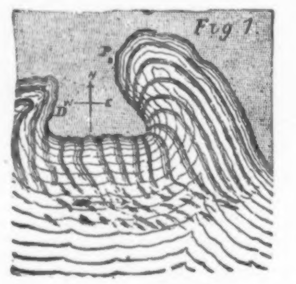
The "hydrostatic" joint is the invention of William Painter, of 44 Holliday street, Baltimore, who may be addressed for all desired information concerning it. It was patented in this country December 11th, 1877, and patents have been secured for it in England, France, Belgium, Germany, Austria, Hungary, and in nearly all the other European countries. Martin Benson, engineer, Southampton Buildings, London, is its European representative.

J. T. H.

## THE CURVING OF WAVES ROUND BAYS AND BREAKWATERS.

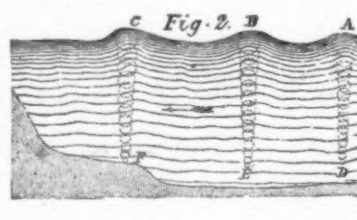
By S. R. DEVERELL.

THERE is a point on the Australian coast, viz., Portland Bay, Victoria, which presents a remarkable case of the curving of waves round headlands. The bay is exposed to the sea in the south-east direction; but the swell from the west curls round and approaches the shore opposite the town in exactly the opposite direction, viz., from east to west instead of from west to east, the direction in which it—urged by the wind—is traveling outside the bay. When thus coming into the bay in its reversed direction, the secondary waves and disturbances on the surface are wholly lost, and




the waves approach the beach in lines of the greatest regularity and shape, affording the best opportunities for observation. On one side of the sweep of the bay is a high cliff (Lighthouse Cliff) which commands a full and complete view across the bay, and from whence the curves assumed by the long lines of waves as they come in from the Southern Ocean are fully exposed to the observer's view, so that it would be difficult to conceive any point affording a more complete panorama for observation.

The first fact which strikes the attention of the observer




is, as has been said, that the waves, divested of their secondary waves and surface disturbances, display themselves in regular lines and ridges of immense length, extending, in fact, further than the eye can reach, which is about twenty miles. Next, that these lines seem to accommodate themselves to the curves in the shore, thus maintaining generally the shape of the shore, but showing a serpentine deviation from it here and there. Thirdly, the distance from crest to crest of two waves is seen to vary at different points of the


lines of their ridges. I think it may be shown that these several effects are produced by the varying velocity of the wave as it is affected by the depth of the water, and that this is the cause also of its curling round headlands and bays, and, in some puzzling cases, breakwaters.

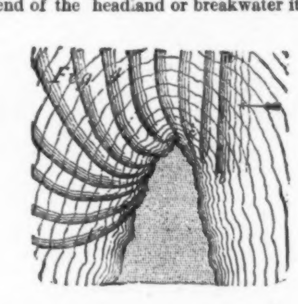
The accompanying diagram (Fig. 1) is an outline of the shape of the bay referred to, the observer being on the cliff at P. The arrow shows the parallel ridges of the waves in deep water, advancing from the west, and the curved lines the paths which the ridges assume in rounding into the bay and reversing or altering their directions. These, it will be

seen, inside the bay show the waves to be progressing from east to west in exactly the opposite direction to that in which they are coming on the other side of the peninsula at D (Nelson Bay), or outside in the deep water of the ocean.

Now Mr. Froude has shown that the velocity of a wave decreases with the depth of water, the orbits of the particles becoming more and more elliptical as they approach shallowing water. To make the present matter clear, let A in the sectional view (Fig. 2) represent approximately the orbits of the particles of water of a wave (advancing in the direction of the arrow) in very deep water, the lower particles having a very small orbit, the bottom or ground being denoted by the shaded line D E F G. If the water continue at the same depth when the wave has advanced to the position B E, the onward velocity will remain the same, but if it come on shallower ground at C F, so that the bottom interferes more with the orbits of the lower particles at F, then the wave at C F will be retarded or its velocity diminished, the orbits becoming elliptical; and if another portion of the same wave comes on still shallower ground, that portion of the ridge will be impeded more than the other, and the ridge (which of course exhibits the onward progress of the wave at the several points) will have a curved form, the curve being more advanced in the deep parts and less in the shallow, as is shown in the plan, Fig. 3, where the arrow shows the direction of the advancing ridge *a b* in uniformly deep water, and the serpentine curve *c d* assumed by it on its meeting with water of different depths. The deeper the water, the more advanced is the ridge of that portion of the wave passing over it, and a person having a bird's-eye view of the ridge can predict precisely under what particular portions of the surface the water shallows. For instance, he will know that there must be a shoal about the position E, in advance of the backward bend of the ridge, and that the deepest water is at F, denoted by the bold advance of the ridge at *d*.

With regard to the varying distance between crest and crest, it requires no demonstration to show that it must be greater where the preceding ridge in advance is unimpeded or in deeper water than where retarded or in shallower water. In shallow parts, therefore, the ridges are closer together and in deep parts wider apart; in other words, the distance from crest to crest increases with the depth, and the deepest part of the water in a bay will be shown by the most prominent or advanced part of the ridge.

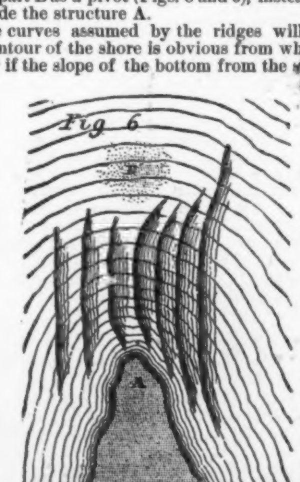
Let *a b* (Fig. 4) be a wave ridge in uniformly deep water, and therefore a straight line. If, however, at the point *b* near the end of the headland or breakwater it strikes shal-



low water, its velocity is consequently, according to Mr. Froude's law, retarded; the ridge there lags behind, and thus presents the appearance of a bent or curved line; in fact, exactly at the end *e* of the point or breakwater the wave actually meeting the shore, its advance is there stopped altogether, and the ridge presents exactly the appearance of a file of soldiers in the act of wheeling round the pivot man, and for the same reason, viz., the varying velocity of each man in the line as he is nearer or further from the pivot; the deeper water outside giving the greater velocity. In this way the wave curls round the obstruction in a curve exactly suited in every part to the shallowness of the water, and so by shallowing the water it will be quite reversed or even brought round in a spiral; numerous natural cases of which may be observed on most coast lines.

But from what has been said, it is evident that in the case of a steep-down headland in deep water, the wave passing the end and having plenty of depth for its advance, without the bottom particles being arrested, will pass straight on with unimpeded velocity, which equaling that of the outer part, the ridge will be a straight line, and the sea will not curl round. If waves, therefore, curl round a breakwater, it would appear that the cure is to deepen the water abruptly at the end and along the inside. Indeed, by so doing and by gradually shallowing the water outward from the end of the headland or structure, the waves may be made to curve round the opposite way, or, so to speak, wheel round the shallower part B as a pivot (Figs. 5 and 6), instead of turning round inside the structure A.

That the curves assumed by the ridges will follow the general contour of the shore is obvious from what has been said. For if the slope of the bottom from the shore edge be




the same all round a bay, as is mostly the case, the same depth of water will be found equidistant from the shore at all points, and the advance of the wave ridge be retarded uniformly all round, and the line of ridge will thus become parallel or concentric with that of the shore; wherever there is a uniform depth of water in a straight line the ridge line will be a straight line, but if the uniform depth be in a

curved line the ridge line must follow that curve. At such a point of observation as that I have named the relative soundings and peculiarities of the bottom throughout are indicated at a glance by the curve lines and positions shown by the ridge line of the waves on the surface.

There are, I am aware, multitudinous phases of the phenomena of the directions taken by waves, as indeed is evident by the diagram in Fig. 1, but all of such conditions would seem to fall under Mr. Froude's simple law of the retardation of velocity in shallowing water.

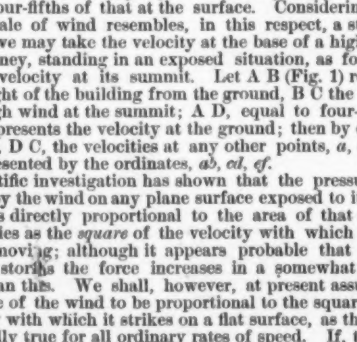
The tendency of waves to amplify or spread laterally is a phenomenon not at all connected with their varying direction. In an article on "Deep Sea Waves," in *Naval Science*, Mr. Merrifield refers to this tendency of waves to spread laterally on passing into a harbor, but the same tendency operates alike in either deep or shallow water.

When a wave is raised at any point, it must, of course, merge gradually into the state of flatness of the surrounding water, or, in other words, extend laterally like the deploying of a line of soldiers; and this would certainly seem to explain the anomalous fact, as vouched for by all seafaring people, that a ship encounters the swell arising from a gale before the gale itself. As the sea travels so much slower than the wind, this prognostic would not be possible in the case of a ship sailing in the track of the wind and sea, but the fact becomes perfectly explicable on the supposition that the vessel meets the lateral extension of the waves before crossing the particular strip in which the originating wind is blowing.—*Engineering*.

## FORCE OF WIND.

THE disasters caused by storms on land are of such frequent occurrence, and so extensive in their effects, that it may be safely affirmed that there is hardly any power in nature more injurious to the works of the builder than the force which is developed by currents of air set in rapid motion. This fact was fully admitted by Tredgold, who, in calculating the strength of the timbers of roofs, considered that the pressure of the wind produced a greater strain than all the other forces to which they were subjected. Lofty towers, spires, and chimneys are not unfrequently overthrown or severely damaged by the fury of the wind; and, indeed, whenever a gale blows with more than ordinary violence, we invariably hear of a large number of accidents having occurred to roofs, chimneys, or other exposed buildings. It is therefore of great importance that the builder should be well informed as to the pressure produced by the wind, so as to be able to determine beforehand whether his structure is capable of withstanding its tremendous power. In the present article we propose to show how the pressure of the wind on various kinds of buildings can be estimated, as well as to explain the principles which ought to regulate the construction of such works as are likely to be exposed to its violence.

There can be no doubt that the velocity of the wind is much greater at a considerable height above the ground than it is at the surface, the irregularities of which offer great resistance to its motion, and tend to retard its speed. Just as in the case of a stream of water, whose velocity is always




found to be much less near the bottom than it is at the surface. This difference, however, is less in currents having high rates of velocity than in those moving sluggishly; and where the stream is very rapid the velocity at the bottom is about four-fifths of that at the surface. Considering, then, that a gale of wind resembles, in this respect, a stream of water, we may take the velocity at the base of a high tower, or chimney, standing in an exposed situation, as four-fifths of the velocity at its summit. Let A B (Fig. 1) represent the height of the building from the ground, B C the velocity of a high wind at the summit; A D, equal to four-fifths of B C, represents the velocity at the ground; then by drawing the line, D C, the velocities at any other points, *a*, *c*, *e*, can be represented by the ordinates, *ab*, *cd*, *ef*.

Scientific investigation has shown that the pressure produced by the wind on any plane surface exposed to its direct action is directly proportional to the area of that surface, and varies as the *square* of the velocity with which the current is moving; although it appears probable that in very violent storms the force increases in a somewhat greater ratio than this. We shall, however, at present assume the pressure of the wind to be proportional to the square of the velocity with which it strikes on a flat surface, as this is undoubtedly true for all ordinary rates of speed. If, then, we take the length, A E (Fig. 1) to represent the square of the number of units in the length A D, *a p* the square of *a b*, B F that of B C, the pressures produced by the velocities at different heights will be represented by the several ordinates of the parabolic arc, E F. In the case of a tower having the same width throughout its entire height, the pressures at the several points, A, *a*, *c*, *e*, B, will be proportional to the numbers (very nearly)—

16, 18, 20, 22½, 25.

The average pressure per foot of surface over each of the four divisions will be nearly in proportion to the numbers

17, 19, 21¼, 23¾.

If we suppose the pressure at the summit to be 50lbs. per square foot, that at the base will be 32lbs., and the average pressures per foot on the four divisions will be in lbs.,

34, 38, 42½, 47½.

Taking the height of the tower as 100ft., and its width as 10ft., the area of each division will be 250 square feet, and the total pressure on the surface will be nearly equal to

$$250\ (34 + 38 + 42\tfrac{1}{2} + 47\tfrac{1}{2})\ \text{lbs.}$$
$$\text{or, } 40{,}500\text{lbs.},$$

that is, 40½lbs. per square foot on an average over the whole surface. To calculate the effect of this pressure in tending to overturn the tower about its base we must find the height, AG, of the center of gravity of the figure, ABFE, at which the resultant of all the pressures will act. By geometry we find that AG is to BG very nearly in the ratio of 54 to 46; so that in a tower 100ft. high the moment of the pressure tending to overturn it will be

$$40{,}500 \times 54.$$

The tower being 10ft. wide, its weight will have a leverage of 5ft. to resist the above force; if, then, W represents the minimum weight of the tower which will just suffice to prevent its being overturned by the wind, we can calculate the value which must be given to W from the equation

$$W \times 5 = 40{,}500 \times 54$$
$$\text{which gives} \quad W = 437{,}400\text{lbs.}$$
$$= 3{,}905 \text{ cwt.}$$

The average weight per foot of height of the tower must therefore be at least 39 cwt., and consequently walls of an average thickness of one brick and a half would just suffice to prevent its being overturned by the greatest force that the wind would ever be likely to exert upon it.

The effect of the wind is frequently seen in the lofty chimney stacks of old houses, which are bent out of the upright owing to a want of proper precautions having been taken in building them of sufficient thickness to resist the long-continued pressure of the wind. Suppose a stack to rise 20ft. clear of a roof, the pressure in this case may be taken as acting uniformly over the whole surface, and if the wall is solid brickwork its weight per cubic foot is about 112lbs. Putting $x$ for the thickness to be found, then the total weight for every foot of width of the stack in lbs. is

$$112 \times 20 \times x, \text{ or, } 2{,}240\,x.$$

This weight acts vertically at a distance equal to half $x$ from the outer edge, so that its moment about the outer edge is

$$2240\,x\frac{x}{2}, \text{ or, } 1{,}120\,x^2.$$

And the moment of the pressure of the wind at 50lbs. per square foot is

$$50 \times 20 \times 10, \text{ or, } 10{,}000.$$

Hence, by equating these two moments we obtain

$$x^2 = 9, \text{ very nearly,}$$
$$\text{or, } x = 3\text{ft.};$$

so that the thickness required must be at least 3ft. in order to prevent the wall from being blown over. As, however, the chimney stack is hollow, and only about half the weight of a solid wall, we must take 56lbs. as the weight per cubic foot, and this gives

$$x^2 = 18, \text{ or, } x = 4\tfrac{1}{4}\text{ft.}$$

The minimum thickness of a hollow chimney stack 20ft. high must therefore be 4¼ft. in order to prevent its being overturned by a pressure of 50lbs. on the square foot. If the height of the stack is only half the above, or 10ft., the strength of the wall must *not* be also reduced one-half, for the thicknesses must be in proportion to the *square root* of the height; so that if $x^2$ is 18 when the height is 20ft., then $x^2$ must be 9 when the height is 10ft., or the thickness $x$ must be 3ft.; and when the height is only 5ft. the thickness should be a little over 2ft. The rule for the thickness may be expressed as follows: If we put $h$ for the height, $x$ for the thickness, $w$ for the weight in lbs. per cubic foot of the wall, $f$ for the pressure of wind per square foot in lbs., the minimum value of $x$ for a wall of any height and weight may be determined from the equation—

$$x^2 = \frac{fh}{w}$$

extracting the square root of the quantity on the right hand will give the required thickness (supposed uniform) of the wall or chimney stack whose height and weight are given. The width of the wall need not be taken into consideration, provided the weight per cubic foot is nearly the same in all parts. Taking $f$ as 50lbs. and $w$ as 112lbs., then the minimum thickness, $x$, of a solid wall of height, $h$, will be

$$x = \frac{2}{3}\sqrt{h}$$

For a hollow wall, whose average height per cubic foot is only 56lbs., the minimum thickness, $x$, for a given height, $h$, will be very nearly $x = \sqrt{h}$.

The force of wind was investigated by the celebrated engineer Smeaton, who found, by taking an average of several experiments, that a wind blowing with a velocity of 35 miles an hour produced a pressure of 6lbs. per square foot on a flat surface exposed to its direct action. Consequently, as the pressure varies in proportion to the *square* of the velocity, a current of air moving at twice the above rate, or 70 miles an hour, produces a pressure four times as great, that is to say, of 24lbs. per square foot. From this we can find the pressure produced by currents of any given velocity; for if $v$ is the rate per hour, $x$ the pressure produced by the rate $v$, then from the above rule we get

$$35^2 : v^2 :: 6 : x$$
$$\text{or, } x = \frac{v^2}{200}, \text{ very nearly.}$$

The following table shows the pressure per square foot on a plane perpendicular to the direction of the wind for different velocities, as calculated by this formula:—

| Vel. of Wind per hour, in miles. | Pressure per square foot, in lb. av. |
|---|---|
| 10 | ½ |
| 20 | 2 |
| 30 | 4½ |
| 40 | 8 |
| 50 | 12½ |
| 60 | 18 |
| 70 | 24½ |
| 80 | 32 |
| 90 | 40½ |
| 100 | 50 |

Except in very exposed situations, or at a great height above the ground, the velocity of wind in this country never exceeds 70 miles an hour, giving a pressure of about 24lbs. per square foot; and if this is taken as the force at the top of a high building, the velocity at its base may be calculated as four-fifths of 70, or 56 miles an hour, and the pressure at 15⅔lbs. When, however, there are no obstructions to lessen the velocity of the wind and deaden its force, it often blows in sudden gusts upon a building, and thereby produces the effect of a battering-ram, which greatly increases the strain on the structure. For example, if a wind which has been blowing at 40 miles an hour, and pressing with a force of 8lbs. on the square foot, is suddenly increased in speed to 80 miles an hour, the pressure at once rises to 32lbs. per foot, in which case a blow equal to 24lbs. per foot of surface is given to the building, in addition to the former pressure of 8lbs. Such a force would be equivalent to a steady and continued pressure of 50lbs. per foot, which is the amount that all buildings in exposed situations must be calculated to sustain.

Roofs of steep pitch surmounting lofty buildings are peculiarly liable to be strained by the wind. If we consider the wind to move in a horizontal direction, and to exert a uniform pressure over the whole surface, we cannot but see that the angle of inclination of a roof materially affects the pressure it sustains from the wind; although Tredgold and other writers on the strength of roof timbers have generally neglected to consider the difference which this makes, and have taken one fixed value for the pressure of the wind per foot of surface, whatever may be the angle of inclination of the roof. A little consideration, however, of the subject by aid of the mechanical principle of the resolution of forces will show that this method gives very erroneous results. For in a roof of low angle the pressure of the wind is hardly appreciable, while in one of high pitch it is nearly as great as that against a vertical wall. Suppose A B (Fig. 2) to represent the slope of a roof making the angle $\theta$ with the horizontal line, A D, and let F P be the direction of the wind at any point, P, moving with a velocity $v$; this velocity resolved in the direction of P O, perpendicular to A B, is $v$ sin. $\theta$. And since the pressure is as the square of the velocity, we have, by the previous formula, pressure per square foot perpendicular to A B equals

$$\frac{v^2.\ \sin^2.\ \theta}{200}$$

In order, then, to find the pressure perpendicular to the surface of a roof of any pitch for any velocity of wind, we must multiply the pressure given in the previous table by the square of the sine of the angle B A D. If the pitch is 30° the sine is ½, and its square ¼, so that when the horizontal pressure is 50lbs per foot, the perpendicular pressure in this case is $\frac{50}{4}$ or 12½lbs. But in a roof of twice that pitch, or 60°, the square of the sine is ¾, so that the pressure on the roof is three times as great, or 37½lbs. On the other hand, with a roof of 15° pitch, the pressure is only one-fourth what it is on one of 30°, or about 3lbs. per foot. The following table will show at a glance what is the pressure at right angles to the surface of a roof for every superficial foot, according to the angle of its inclination to the horizontal, the wind being supposed to blow horizontally with a force of 50lbs. per foot on a vertical surface.

| Pitch of roof in degrees. | Pressure of wind per ft. in lb. av. |
|---|---|
| 10 | 1½ |
| 15 | 3¼ |
| 20 | 6 |
| 25 | 9 |
| 30 | 12½ |
| 35 | 16½ |
| 40 | 20½ |
| 45 | 25 |
| 50 | 30 |
| 55 | 33½ |
| 60 | 37½ |
| 65 | 41 |
| 70 | 44 |
| 75 | 46½ |

It will be seen from the figures in the above table that the force of 40lbs. per foot, which is given by Tredgold as the pressure on a roof surface, is much too great for the roofs of low pitch, which he advocates, and for which the strength of his timbers are calculated. In estimating the effect of the wind on a roof of high pitch, it must be borne in mind that the pressure can be only on one side at a time, and that there is no counterbalancing force on the opposite side. From this circumstance it arises that a far greater strain is produced upon the trusses than if the same load pressed on both sides of the roof at once.

Hitherto we have considered the pressure produced by the wind upon planes or flat surfaces only: we will now extend inquiry to the case of a cylindrical surface, and since the pressure thereon must vary at every point, it will be necessary to call to our aid the processes of the integral calculus.

Let A P B (Fig. 3) represent a quarter of the plan of a cylindrical tower on which the wind acts horizontally at any point, P, in the direction, F, P, where the radius, O P, makes the angle, $\theta$, with the direction of the wind, supposed to be parallel to F P all over the surface of the tower. The velocity resolved in the direction of P O, or perpendicular to the tangent at P, is $v.\cos.\theta$, and the pressure at P is proportional to $v^2.\cos^2\theta$. Now, the only part of this pressure which tends to overturn the tower is the resolved part in the direction P $p$, which is found by multiplying the pressure down P O by the cosine of $\theta$, so that the force in P $p$ is proportional to $\cos.^3\theta$ for any given velocity. The pressure on any small arc, P Q, is to that on the corresponding part of the radius $p\,q$ as $r.\ d\theta.\ \cos.^3\theta$ is to $dr$, $d\theta$ and $dr$ being the differentials of the angle and the radius respectively. Therefore, for the whole quadrant, A. B, the pressure on the ring is to that on the radius as

$$\int r.\ \cos.^3\theta.\ d\theta \quad : \quad \int dr$$

These integrals, taken between the limits 0° and 90° for the angle, give us the ratio of

$$\tfrac{2}{3} : 1, \text{ or } 2 : 3$$

Therefore, if there are two towers equal in height and diameter, one being square and the other cylindrical, the pressure sustained by the former is to that borne by the latter in the proportion of 3 to 2, the wind blowing horizontally with equal velocity on each, and its direction being perpendicular to one side of the square tower. If then we suppose the utmost pressure which the side of the square tower will have to sustain, to be 40lbs. per square foot on an average over the whole surface, the pressure on the cylindrical one will be 27lbs. for every foot superficial in a vertical section taken on a diameter of the circle. The weight, however, of the circular tower is less than that of the square one in the ratio of 11 to 14, if the walls are of the same thickness in each case If the tower 100ft. high and 10ft. diameter, mentioned above, were circular instead of being square, the pressure tending to overturn it would be 27,000lbs., and its minimum weight must average 26 cwt. per foot of height; so that, in order to offer equal resistance to the overturning force, the thickness of the walls must be about the same in the round as in the square tower. It has been stated by Rankine and other writers that the pressure on the cylindrical tower is only half that on a

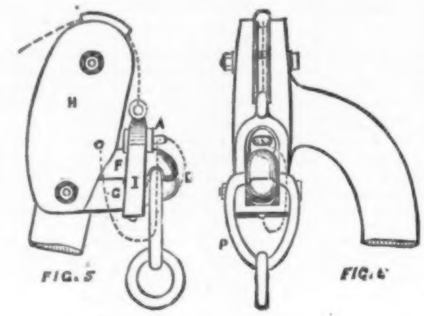
square one of equal diameter. This, however, gives too low an estimate of the force which the former has to sustain, the proportion of 2 to 3 being the one that should be adopted. This result shows that it is much more economical to build a tall chimney circular on plan than square, as a saving of one-third of the material can thereby be effected.

The principles which have been here laid down will serve as a guide to the solution of all problems relating to the pressure of the wind on buildings; but it will generally be found necessary to consider each particular case according to the circumstances under which it may be placed, as a slight variation in these may materially affect the conditions of the problem.—*Building News.*

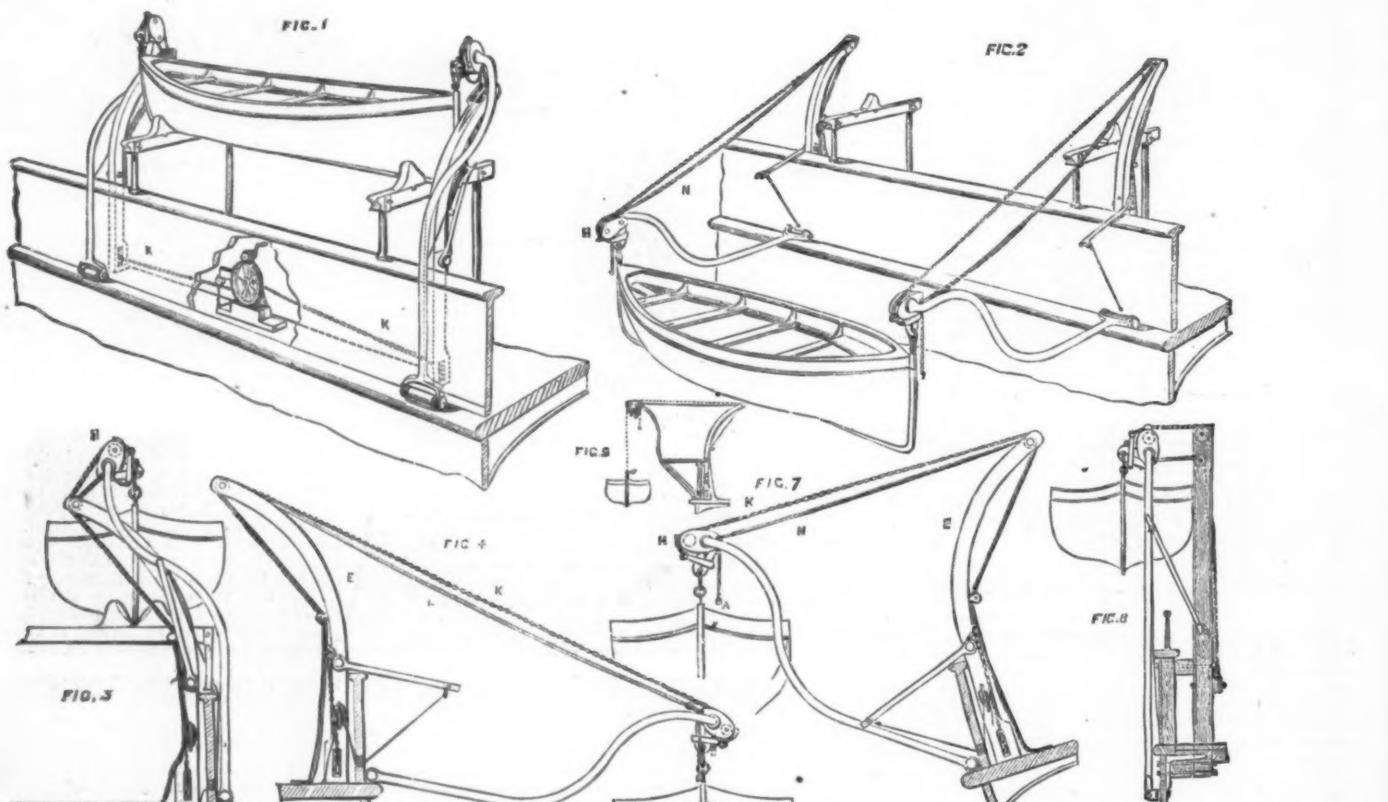
## IMPROVED BOAT LOWERING APPARATUS.

WE illustrate herewith a new form of apparatus designed by Mr. G. G. Laurence, of the Tay Bridge Works, Newport, Dundee, and which effects the raising and lowering of a loaded ship's boat in any sea, and permits the actual release to be made instantaneously at the most favorable moment. In our illustrations, Figs. 1 and 3 show the apparatus when the boat is inboard and resting on the skid beams. Figs. 2 and 4 show the position of the fixed and moving davits when the boat is lowered and suspended ready for dropping it into the water. In Fig. 7, the position of the parts is shown when the boats is suspended outside the vessel in a rough sea. A simple form of the apparatus has been fitted on board a schooner, the Lightning, as shown in Fig 8, and with most successful results. The apparatus has also been fitted on one of the Tay Ferry Company's steamers, Dundee, and by it a boat weighing 15 cwt., and stowed one foot inside the perpendicular of the bulwark, was repeatedly launched, loaded with her crew while going full speed, in about 30 seconds, and hoisted and restored in less than a minute. In Fig. 9 the apparatus is indicated with the strut bar in the position by which it maintains the moving davits a certain distance from the vessel's side during the hoisting operation. In Figs. 5 and 6 are shown enlarged views of the davit head.

A head is formed on the upper end of each davit. Each head H is formed to receive a sheave E, and is also fitted with a pair of jaws D. One jaw F is fixed, and the other jaw G is hinged to the head. A shackle I is formed to slip over the two jaws, and with an eye for attachment to a fall K, the end of the fall being attached to a spring safety hook. The chain K passes over the sheave E, and over one of two sheaves mounted in the head of the standard E. The chain K is then led from the standard to a winch, as seen in Fig. 1. The two chains K from both davits are led to the same winch N. See Figs 4 and 7. One end of a rope or fall is attached to an eye formed on the davit as shown. This fall is led over the other of the two sheaves in standard E, and is attached by the other end, so that it can be lengthened or shortened or made fast, as required. The jaws D are so formed that, when closed a link P can hang freely within the jaws and be therein retained. The link is connected by a short chain to the end of the boat. The inward projection of the davit heads permits the boat to swing clear between the two davits when they are hauled inboard. It will be seen that when suspended the weight of the boat is sustained by the hinged jaws, and that when these are permitted to open by the removal of the wedge A, the boat will be released. The method of lowering the boat is as follows:—We will suppose the boat to have been unshipped from the skid beams upon which it rests in Figs. 1 and 3, and pushed off so that the davits are kept from falling outward by the chains K K, as seen in Fig. 7. The chains are now slackened off and the davits are permitted to fall outward, the lower ends turning on their hinges and swinging the boats clear of the ship's side. As the upper ends of the davits move over, the loose wedges A fall out of the shackles I, but as the strain due to the load is borne by the latter, the movable jaw is held firmly against the fixed jaw, and the ring P is firmly held. When the boat is nearly low enough to be released the chain and pin falls will be as shown in Figs. 2 and 4, the falls N being so adjusted in length as that they will tighten when the boat is low enough to be released. The lowering of the boat continuing, the falls N take the load, so that the chains K slacken, and the closing strain being thus taken off the movable jaws, the boat is released and drops into the water. By this method, and supposing the falls N to have been previously adjusted, it would be simply neces-




sary to run out the chains K until the boat became released by the tightening of the falls N, but the latter may be operated at will so as to drop the boat at any moment. When the boat is to be raised the davits are fixed in the positions shown in Fig. 7. The chains being unhooked and overhauled down to the boat, the hooks are then attached to the lower rings on the boat, and the latter is hoisted to the davit heads. The links P are then placed in the jaws, and the wedge being inserted, the davits and boat are brought inboard together.—*The Engineer.*




IMPROVED BOAT LOWERING APPARATUS.

## H.M.S. "IRIS."

HER MAJESTY'S twin-screw steel dispatch vessel Iris, which was launched at Pembroke in April last, lately made a contractors' trial of her machinery.

The principal dimensions of the Iris are—length between perpendiculars, 300 ft., and over all, 333 ft.; extreme breadth, 46 ft. 1 in.; depth in hold, 16 ft. 3 in.; length of poop, 78 ft.; mean draught, 19 ft. 9 in.; displacement, 3,750 tons; and midship section, 777 square feet. Unlike the steel vessels of the Comus class, which are now building on the Clyde, she will not be sheathed with wood, but will have her hull simply protected by composition. The plating varies from ⅝ in. to ⅜ in. in thickness, and is riveted to the longitudinals and perpendiculars by wrought-iron rivets ⅞ in. in diameter. There are 83 frames, those forward and aft being 3 ft. apart, and those amidship 4 ft. apart, and, as they are crossed by longitudinal Z-shaped girders, no part of the ship's side is unsupported for more than 4 ft. square. Her armament will consist of ten 64-pounders, eight side and two revolving, the latter being mounted on the poop and forecastle, so that the recessed ports which have been cut in the corvettes of the Boadicea class for the purpose of securing fore and aft fire will be dispensed with. The broadside guns, which are worked on the upper deck, have no protection beyond the ⅜ in. plating which forms the topsides, and runs up so as to give an exceptional height of bulwark and freeboard. Her weight of shell is 1,395 tons. The Iris will also carry a 9-pounder and a 7-pounder field-piece, and will be fitted with the Whitehead torpedo. Her armament is undeniably light. She is bark-rigged, with wooden masts, and is steered by hand-gear. Her complement is 250, and the officers are for the most part accommodated under the poop.

Like the hull of the ship itself, the engines, which are manufactured by Messrs. Maudslay, Sons, & Field, are of novel construction, there being nothing resembling their cylinder and valve arrangements in the service, with the exception of those which were fitted by Messrs. Maudslay to the machinery of the Sirius, corvette, in 1867. The ship is propelled by direct-acting, horizontal, compound four-cylinder engines designed to turn twin screws. They are driven with 60 lbs. pressure of steam, are intended to work up to 7,000 indicated horse-power, and are calculated to make about 95 revolutions per minute when developing their contract power. There are in all four high-pressure cylinders, having a diameter of 41 in., and four low-pressure cylinders, with a diameter of 75 in., the stroke being 3 ft. Each high-pressure cylinder is bolted to the front of the low-pressure cylinder with which it works. It is also, for the purpose of economizing length, partly recessed into it, and one piston rod carries the two pistons. The engines are placed in separate engine-rooms, divided by a water-tight doorway, the starting platforms of each pair of engines being situated close to and conveniently adjoining the doorway. The narrow beam of the ship for engines of the size and power has rendered it necessary to place the starboard engine in front of the port engine, so that the body of the ship is well-nigh filled with machinery. The requirements of the vessel having also limited the weights of the engines, the piston rods have been connected to wrought-iron cross-heads working on guide rods which form the connection between the main crank-shaft bearings and the cylinders, and to each of which they are bolted with strong T ends. The surface condensers, which are constructed entirely of brass, are placed in the wings behind the cylinders. The one in the forward engine-room is fitted with 5,290 tubes, 7 ft. long and ⅝ in. in diameter in the inside; while the after condenser contains 7,024 tubes of the same internal diameter, but with a length of only 5 ft. 3 in. The total cooling surface is 14,000 square feet. The air-pumps are of the upright single-acting description. They are also placed at the rear of the cylinders, and are worked by bell-crank levers direct from the piston of the foremost low-pressure cylinder in each compartment, an arrangement which was deemed expedient on account of the limited space in the engine-rooms. The slide valves of each pair of cylinders are worked by one link, and the engines are fitted with steam starting and reversing gear. The crank-shafts are double-throw, and were forged by the Thames Iron Works Company. The line of screw shafting, which is hollow, is constructed of Whitworth compressed steel, with a 9 in. hole through its center; and it may be mentioned that the low-pressure cylinders are each lined with working barrels of the same metal. The engines give motion to a couple of four-bladed screw propellers, 18 ft. 6 in. in diameter, and so adjusted that the pitch can be varied from 17 ft. 6 in. to 22 ft. 6 in. At the preliminary trial the pitch was set at 18 ft. 8 in., but, as the engines could not take all the steam that was generated, the pitch was subsequently reduced to 17 ft. 6 in. The outer edges of the blades are unusually fine, and to show their great power relatively to the size of the ship, it may be stated that their outer edge comes to within 3 ft. 5½ in. of the extreme beam. In order that the screws may obtain a good supply of water and exercise their full power of thrust, the tubes are carried out 51 ft. from the body of the ship.

Steam is furnished by twelve boilers of slightly different dimensions in order to meet the varying line of the ship's bottom. They are placed at the wings, and are fired amidship. They are also disposed into two water-tight compartments, six in each, the object being that if one set of boilers were rendered useless by reason of the compartment becoming flooded, the engines could be driven from the other set; and with this contingency in view, the steam pipes connecting the boilers with the engines have an outer metal cover-

ing to prevent the radiation of heat in the event of their being surrounded by water. It also deserves to be mentioned that the doors in the water-tight bulkheads which separate the fore engine-room from the stokeholes and the stokeholes from each other are placed near the top instead of upon the flat. Should the ship, therefore, be rammed, the inflowing water would be confined to one compartment sufficiently long to enable the doors to be leisurely closed. The stokeholes are admirably ventilated by wide annular spaces in the two funnels, up which the hot air rushes and causes a correspondingly vigorous inflow of fresh air through the coals and funnel casings. The boilers are fitted with 2,898 brass tubes, 6 ft. 6 in. long and 3¼ in. external diameter, the total heating surface being 18,700 square feet. There are in all 32 furnaces, each 7 ft. long by 3 ft. 1½ in. wide, and possessing a total area of grate surface of 700 square feet. In order to save weight as far as possible, the outer shells of the boilers are made of the Landore Company's mild steel, of similar quality to that of which the hull itself is built. The stop-valves can be worked from the main deck, and are also to be worked from the upper deck. The Iris carries 500 tons of coal in her ordinary bunkers, and 250 tons additional in her reserve bunkers. The total weight of the machinery, with water in the boilers and condensers, is about 1,000 tons, and the contract price is £93,000.

The Iris is the first ship in the service which has been specially fitted for working with steam as low as atmospheric pressure. Mr. Sells, a gentleman connected with the contractors' firm, has patented an ingenious duplex valve arrangement, whereby the communication between the exhaust of the high-pressure cylinders and the low-pressure slide chest is cut off, and the steam passes instead into the main exhaust pipe, while at the same time other valves are opened which admit steam directly from the boilers into the low-pressure cylinders.

On Friday last the Iris made a six-hours' full-power run. From first to last the ship was made to travel a distance little short of 120 knots, of which 96 were accomplished during the official six hours, and took her considerably to the west of Portland. As the days are short for extended trials of the kind, steam at the beginning was forced; the consequence was that the boilers primed, and the first half hour was lost before the priming could be arrested, and though the ship weighed anchor at half-past 9, it was not until close upon 11 o'clock that the note taking was commenced. No further drawback occurred, the engines maintaining a marvelous uniformity in the vacuum and the number of revolutions, with a mean pressure of steam in the boilers of 62 lbs. The starboard engine made 91 and the port engine 89¼ revolutions per minute; the mean vacuum in the after condenser was 28.33, the vacuum in the forward condenser remaining at 28 in. throughout the day. The mean pressure of the steam in the high-pressure cylinders was 41.29 and in the low-pressure cylinders 11.24, the mean total horse-power developed being 7088.52, or 88½ horses beyond the contract. The speed of the ship, as recorded by the electric log, and confirmed by cross-bearings taken by Lieutenant Wonham, was 16 knots per hour, being less than was anticipated from the mould of the ship. The consumption of coal during the trial amounted to 2.7 lbs. per indicated horse-power per hour. No attempt, however, was made in the way of economizing fuel, and during the run home common Welsh coal was burnt.—*London Times.*

## SUCCESSFUL LIFTING OF A SUNKEN STEAMSHIP.

SINCE the sinking of the Edith packet boat in September, 1875, by the Duchess of Sutherland, another packet boat in the same service, that of the London and Northwestern Railway, the wreck of the submerged vessel has been a source of danger to vessels in the neighborhood. Several attempts have been made to raise the Edith, which have been unsuccessful. The directors having advertised in vain for tenders for removing the Edith, placed the matter in the hands of the Victoria Graving Dock Company, whose business of docking ships by lifting them out of the water by Mr. Edwin Clark's process has afforded them special experience in this direction. The dock company's engineer, Mr. Druitt Halpin, designed special apparatus to lift the submerged vessel by means of enormous iron pontoons, raised partly by the tide and partly by their own buoyancy when pumped free of their contained water, the pontoons being previously connected with the ship. The Edith is 250 feet in length, with 30 feet beam and a depth of 15 feet, her gross register being about 900 tons. She settled down in 36 feet of water at low water spring tides, the rise and fall of the tide in Holyhead harbor being 16 feet at spring tides and 12 feet at neaps. The Duchess of Sutherland ran into her starboard bow, making an ugly gap, extending several feet below her water line. The apparatus by means of which the Edith was raised consists of two cradles, one of which was placed near the stern and the other near the bows of the vessel. Each cradle consists of two wrought-iron caissons or tanks, each 60 feet long by 15 feet wide and 15 feet high. Each caisson is divided into four watertight compartments by means of three iron bulkheads, so that each compartment is isolated from the other. The two caissons are connected together by eleven girders, each 63 feet long and 5 feet deep, which are bolted to the tops of the caissons, thus holding them rigidly apart at a uniform distance of 33 feet from each other. On the tops of the girders, and in line with the inner face of each caisson, are twenty small towers or lighthouses, as they are termed, ten on each side. These lighthouses are carried on balks of timber, and are themselves 9 feet high. They are constructed of open lattice pattern of wrought iron, and each carries a long hook with a screw 3¼ inches in diameter for adjusting the connection with the ship. The screw is suspended in the lighthouse, and is worked from the top by a large spanner, capstan fashion, the screw passing through a cast-iron cap at the top. The lighthouses on each side also carry a timber platform 12 feet wide, and running the whole length of the cradle, and from which the screwing and other operations are performed. The connections between the cradles and the ship are made by means of steel wire ropes, having hooks at their lower and eyes at their upper ends. The hooks were placed in the ports of the vessel, or where the ports did not conveniently occur, in holes which had been previously cut by divers in her side plates. The upper ends of the wire ropes were led up to the lighthouses and connected with the screw hooks, which were then screwed up until all the wire ropes were put in uniform tension, and the vessel and cradle were firmly connected together. The wire ropes are calculated to withstand a safe strain of 30 tons each; one of them, however, on being tested, stood a strain of 80 tons before giving way. On Tuesday, the 4th instant, the cradles were towed out at high water from their moorings in the inner harbor and placed in position fore and aft of the Edith. The hooks had already been placed in the holes, and the wire ropes were led up to the towers and coupled up to the screwed hooks on the cradles at low water. The hooks were then screwed up and the wire ropes made taut, an even strain being brought on them all so that the Edith was fairly held, that she might rise evenly suspended between the pontoons. The tide then began to make, the engines were started, and the water was pumped out of the caissons. As the tide rose, so the pontoons, with the Edith in their firm and even grip, rose together in the fair, even lift. A steamtug, the Sunshine, was then attached, and towed the ship and cradles inshore for a distance of nearly half a mile. The ship grounded at the top of high water, and next morning the cradles were detached and towed back into the inner harbor for repairs, one of the tanks having sustained some slight damage as the tide receded. By the afternoon of the 5th the damages had been repaired and the cradles were ready for another lift, but the weather was unpropitious, and remained so until Saturday, the 8th, when the cradles were floated out at midday. The Edith was again connected with the cradles by means of wire ropes and hooks, and in the evening, when the tide made, the ship and her captors were once more evenly afloat. They were then towed inshore for another short distance, as far as the depth of water would permit, and the vessel was allowed to settle down on the bottom with the ebb tide. The ship and apparatus still remained connected, and on the morning of the 9th they again rose with the flood tide, the wire rope having in the meantime been again shortened. By means of a hawser and a purchase crab made fast on land they were hauled close inshore to the present position of the ship, which is some 70 or 80 feet outside the Admiralty Pier. She lies on the sloping bank with her bows toward the shore and with 10 feet of water aft and 5 feet forward at low water of spring tides, what remains of her deck-houses and paddle-boxes being visible at high water. After the Edith had settled down, the cradles were finally detached and towed round to their berths in the inner harbor.—*Iron.*

## WAR SHIPS OF EUROPE.

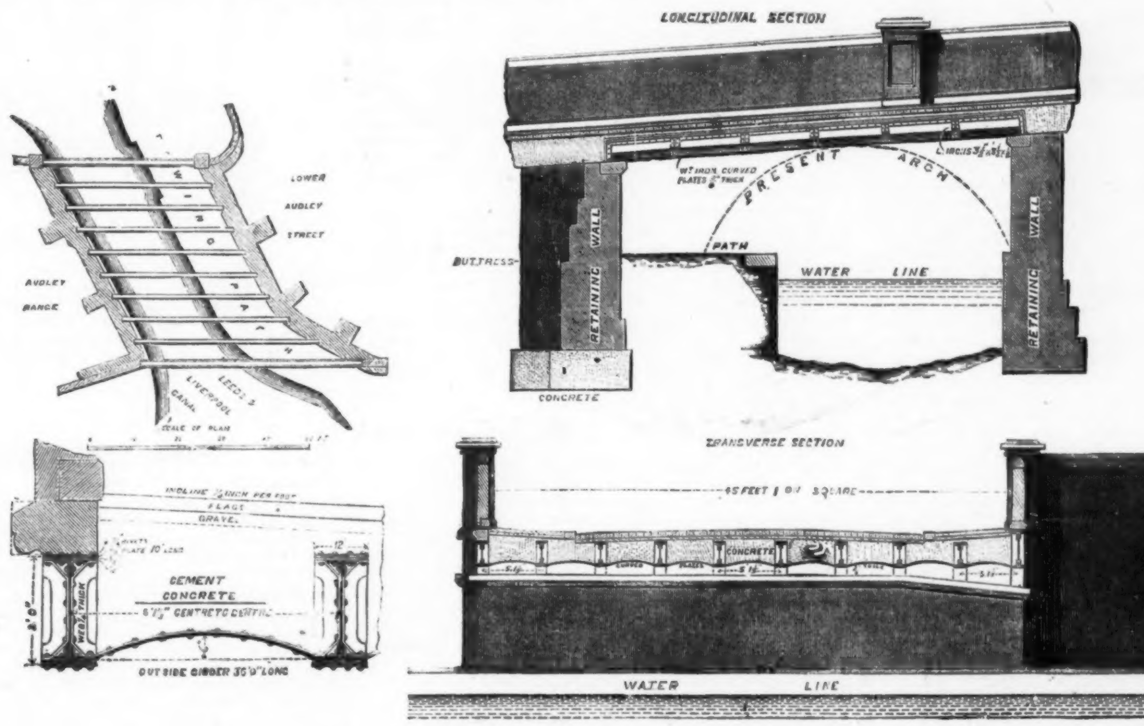
ENGLAND has 152 active vessels and 350 in reserve, 60,300 sailors with 3,000 officers, and 15,000 marines with 326 officers, and 10 monster ironclads. France has 115 active vessels and 78 in reserve, 48,000 sailors with 1,800 officers, and 16,000 marines with 780 officers, 3 monster ironclads, and 9 smaller coast boats. Germany has 61 active vessels and 48 in reserve, 8,000 soldiers and marines with 500 officers, and 3 ironclads. Russia has 158 active vessels, mostly small, 60,000 sailors with 2,000 officers, only one-third serving on board ship, and 1 monster ironclad. Austria has 68 active vessels, 7,000 sailors with 500 officers. Italy has 65 active vessels, 12,000 sailors with 425 officers, and 3,000 marines with 115 officers, and 2 monster ironclads, the largest in existence, carrying 8 100-ton guns. Turkey has 57 active vessels and 28 in reserve, 36,000 sailors and marines with 1,000 officers, and 7 ironclads. Spain has 128 active vessels, 21,000 sailors and marines with officers, and 3 small ironclads. Greece has 21 active vessels, 7,000 sailors and marines. Denmark 33 active vessels, 10,000 sailors and marines. Holland 87 active vessels, 12,000 sailors and marines.

## CANAL BRIDGE AT BLACKBURN, ENG.

A NEW girder bridge over the Leeds and Liverpool Canal, at Audley, near Blackburn, to take the place of an arch which now exists, is proposed, as shown in the engravings, which are from the *Engineer*. The following abstract of the specification shows the nature of the work to be performed. The site of the proposed bridge is under half a mile from the goods stations of the Lancashire and Yorkshire and London and North-Western Railway Companies. The contractor to provide the whole of the materials and labor required in erecting the ironwork of the proposed bridge. He must be at the expense of all machinery, tackle, implements, and all other things necessary for getting the girders into position. He will be assisted by the stone masons so far as is necessary.

The whole of the wrought iron to be equal to the best Staffordshire, and its tensile strength per square inch of section to be not less than 20 tons. The girders to be built as shown on drawings. The 36 ft. and 37 ft. 6 in. girders to have 1 in. camber, the 42 ft. to have 1¼ in., and the 50 ft. to have 1½ in. The rivets to be thoroughly forced home, and the cup heads neatly finished. Where the girders rest on the abutments, the rivet heads to be countersunk. The angle irons and plates to be in as long lengths as possible. At all joints proper cover plates and angle irons as may be required to be provided. The cover plates are not shown on drawings. The floor plates to be bent to the exact curve as shown, to be ⅜ in. thick, and to be riveted to the lower flange of girders, as shown. At all joints, cover strips 6 in. wide to be riveted; 3½ in. by 3½ in. by ½ in. angle iron to be riveted to the outer edges, which are to be cut to the proper skew, as shown. The ironwork to be inspected by the engineer before being painted. The whole of the ironwork to have a good coat of best red lead paint before leaving the works. All the iron work must be weighed on the Corporation weighing machine before being delivered on the site of the works. The ironwork to be left perfect and complete, and to the satisfaction of the engineer. The whole of the iron-work to be delivered in Blackburn before 20th January, 1878. The following are the approximate quantities of the ironwork, any cover plates at joints not included, but the contractor must check them :

| | Tons. | cwt. | qrs. |
|---|---|---|---|
| No. 7 girders, 36 ft. 0 in. long, with stiffeners 6 ft. 0 in. c. & c. .. | 18 | 18 | 0 |
| No. 1 do. 37 ft. 6 in. do. do. 6 ft. 3 in. c. & c. .. | 2 | 16 | 1 |
| No. 1 do. 42 ft. 0 in. do. do. 6 ft. 0 in. c. & c. .. | 3 | 6 | 2 |
| No. 1 do. 50 ft. 0 in. do. do. 6 ft. 3 in. c. & c. .. | 4 | 17 | 2 |
| Curved plates.......... | 10 | 4 | 2 |
| Angle irons to ditto.......... | 0 | 10 | 2 |
| | 40 | 13 | 1 |




NEW CANAL BRIDGE, BLACKBURN, ENG.

ALTHOUGH a steel plate cannot be pierced by a shot which will go through an iron plate of equal thickness, the steel is much more easily broken up and torn from the timber behind it than is the iron, thus leaving the inner shell of the ship vulnerable to the attacks of comparatively light guns.

## TUNNELS AND ROCK-BORING MACHINERY.

By John Darlington.

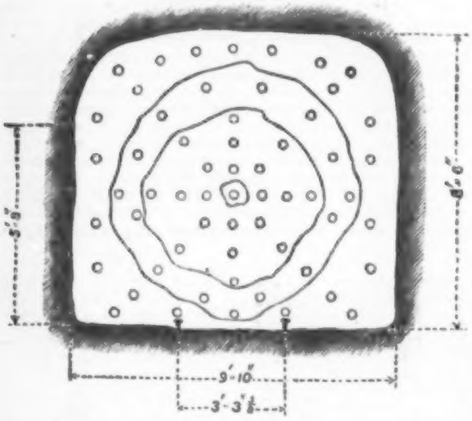
### TUNNELS.

1.—The Mont Cenis Tunnel, where for the first time rock-boring machinery was rendered permanently successful in 1861. Rock—Mica schist, quartzite, crystalline, and clay-slates. Dimensions of level—Height, 8 ft. 6 in.; width, 9 ft. 10 in.; length, 40,000 ft.; section of forebreast, 83½ ft.; number of holes bored in forebreast, 55 to 65; diameter of holes, 1⅝ in. at top, 1⅜ in. at bottom; depth of holes, 2½ ft. to 4 ft.; number of borers simultaneously employed, 10; number of strokes made by borer per minute, 250.

Fig. 16 shows the form of the heading, the position of the various shot-holes made around the axial line of the heading, and the rupturing lines of the blast. The cost of each boring machine was £80; compressed air consumed per machine, per 14 to 15 hours, 5,500 to 6,000 cubic feet; water required for drilling, 60 to 70 holes, 600 to 700 gallons.

2.—St. Gothard Tunnel. Rock—Granite, and compact mica and other schists. Dimensions of level:—Goeschenen: Width, 8 ft. 10 in.; height, 8 ft. 2 in.; section of face, 79

60 HOLES.

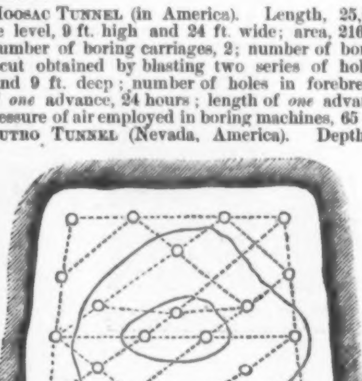



square feet; number of borers employed, 6; average number of holes bored in forebreast, 26; depth of holes, 3 ft. 6 in. Airolo: Width, 8 ft. 6 in.; height, 8 ft. 2 in.; section of face, 69½ ft.; number of borers simultaneously employed, 6; diameter of holes, 1⅝ in. at top, 1 3-16th in. at bottom; average number of holes, 25; depth, 3½ ft. to 7 ft.; number of blows made per minute by the Ferroux borer, 350 to 400; by the François and Dubois, 300. Total length of tunnel when complete, 48,950 feet.

Fig. 17 represents the end of the Goeschenen level, perforated with 26 holes; and Fig. 18 the Airolo end, perforated with 25 holes.

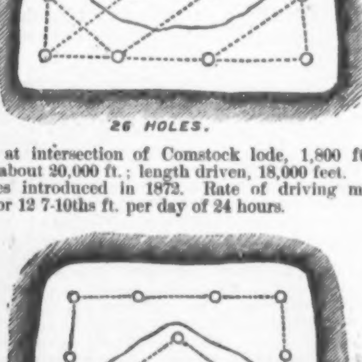
3.—Hoosac Tunnel (in America). Length, 25,000 ft.; advance level, 9 ft. high and 24 ft. wide; area, 216 square feet; number of boring carriages, 2; number of borers, 10; center cut obtained by blasting two series of holes, 9 ft. apart and 9 ft. deep; number of holes in forebreast, 40; time of *one* advance, 24 hours; length of *one* advance, 7½ feet; pressure of air employed in boring machines, 65 lbs.

4.—Sutro Tunnel (Nevada, America). Depth below



26 HOLES.

surface at intersection of Comstock lode, 1,800 ft.; total length, about 20,000 ft.; length driven, 18,000 feet. Boring machines introduced in 1872. Rate of driving monthly, 305 ft., or 12 7-10ths ft. per day of 24 hours.

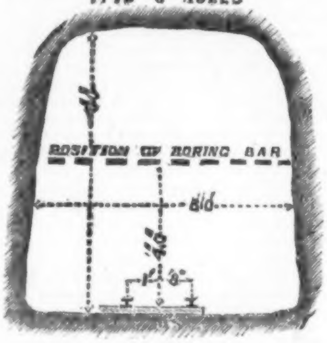


25 HOLES.

5.—Musconetcong Tunnel (see Figs. 13 and 14). Rock—Syenite. Length driven through this rock, 1,725 ft.; width of tunnel, 26 ft.; height, 8 ft.; net area of face, 175 square feet; contents per lineal yard, 525 cubic feet; diameter of bore-holes, 1¼ in. to 2⅜ in.; depth of holes, center cut, 10½ ft.; squaring up holes, 12 ft.; roof holes, 8 ft. to 10 ft.; number of pounds of dynamite used to 36 holes—first quality, 25 lbs.; second quality, 245 lbs.—total, 270 lbs., or 7½ lbs. per hole; number of borers employed simultaneously, 6; strokes made per borer per minute, 300 to 400; diameter of cylinder of boring machines, 5 in.; pressure of air employed, 50 lbs. to 60 lbs.; time required to bore and blast holes, remove debris, and square ground, 32 hours; rate of advance for 24 hours, 6 ft. to 7 ft.

6.—Severn Tunnel (Fig. 19). Rock—Pennant, or coarse sandstone; height of level, 8 ft.; width, 8 ft.; net area (say), 60 ft.; contents of a cut, 90 ft. to 120 cubic ft.; two boring machines employed; sectional area to one machine, 30 ft.; number of blows made by borer per minute, 300 and above; diameter of hole, 1½ in.; depth of holes, 18 in. to 24 in.; tool, × point; number of holes bored in three hours, 14 to 16; position of holes, variable; diameter of air main, 2 in.; diameter of galvanized sheet-iron exhaust pipe, 12 in.; exhauster, a large fan; duration of shift, 8 hours; number of shifts in 24 hours, 3; forebreast of level from shaft, 800 to 900 yards; depth of shaft, 200 ft.; length of tunnel when complete (say), 4 miles.

14 TO 6 HOLES



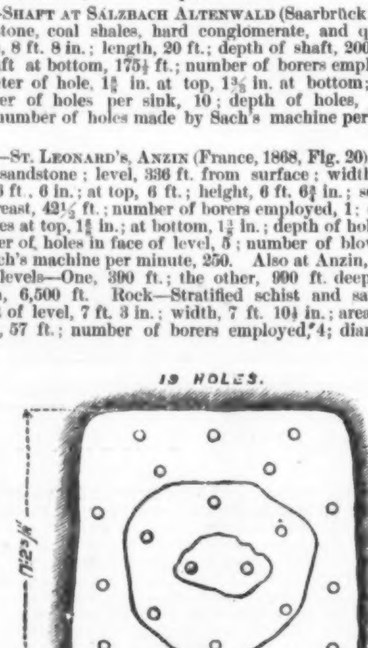

7.—Mines and Collieries (the Altenberg Zinc Mines, Aix-la-Chapelle). Rock—Hard grauwacke schist; a cross-cut 290 ft. from surface; length, 413 ft.; height, 7 ft. 3 in.; width, 7 ft. 3 in.; area of forebreast, 52½ ft.; number of borers employed, 2; diameter of holes, 1⅜ in. at top, 1 in. at bottom; depth of holes, 1 ft. 8 in. to 3 ft.; number of holes in forebreast for one advance, 10 to 12; number of blows made by Sach's borer per minute, 250 to 400.

8.—Perseberg Mines (Sweden). In 1867 a level driven 9 ft. by 8 ft.; area of face, 72 square feet. Rock—Garnet, hornblende, augite, and epidite; number of borers employed, 1; diameter of hole, 1¼ in.; depth, 2 ft.; number of holes bored in a shift, 8 to 10; number of blows made by Bergström's machine, 200 to 300 per minute.

9.—Shaft at Sálzbach Altenwald (Saarbrück in 1867). Sandstone, coal shales, hard conglomerate, and quartzite; width, 8 ft. 8 in.; length, 20 ft.; depth of shaft, 200 ft.; area of shaft at bottom, 175¼ ft.; number of borers employed, 1; diameter of hole, 1⅝ in. at top, 1⅜ in. at bottom; average number of holes per sink, 10; depth of holes, 21 to 24 in.; number of holes made by Sach's machine per minute, 300.

10.—St. Leonard's, Anzin (France, 1868, Fig. 20). Coarse grain sandstone; level, 336 ft. from surface; width at bottom, 6 ft., 6 in.; at top, 6 ft.; height, 6 ft. 6¾ in.; section of forebreast, 42½ ft.; number of borers employed, 1; diameter of holes at top, 1⅝ in.; at bottom, 1⅜ in.; depth of holes, 2 ft.; number of holes in face of level, 5; number of blows made by Sach's machine per minute, 250. Also at Anzin, in 1869. Two levels—One, 390 ft.; the other, 900 ft. deep; length driven, 6,500 ft. Rock—Stratified schist and sandstone; height of level, 7 ft. 3 in.; width, 7 ft. 10¼ in.; area of forebreast, 57 ft.; number of borers employed, 4; diameter of

19 HOLES.




holes at top, 1⅝ in.; at bottom, 1⅜ in.; depth of holes, 5 ft. to 6 ft.; number of holes in forebreast, 19; number of blows made by Dubois and François borers per minute, 150 to 200.

11.—Marihaye (Belgium). Levels—One, 1,350 ft. deep; the other, 1,470 ft.; more than 6,500 ft. driven. Rock—Coal schist and sandstone, the latter inclosing fine grains of quartz; width of level, 7 ft. 3 in.; height, 7 ft. 3 in.; area of forebreast, 52¼ ft.; number of borers employed, 4; diameter of hole, 1⅝ in.; depth of hole, 3 ft. to 4½ ft.; number of holes in forebreast, 20 to 30; number of blows made by borer per minute, 250.

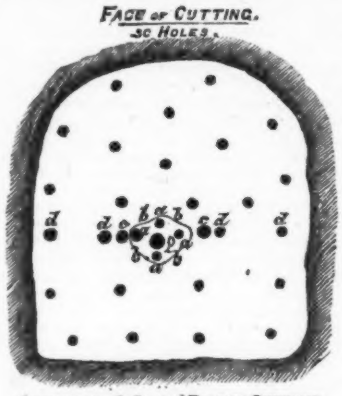
12.—Marie Colliery (Belgium, Fig. 21). Driving level from shaft; width of level, 5¼ ft.; height, 6 ft. 6¾ in.; area of face, 34 square feet; number of borers employed, 4; diameter of hole at top, 1½ in.; at bottom, 1¼ in.; depth of hole, 6 ft.; number of holes in forebreast, 30; number of blows made by Dubois and François borers per minute, 250.

13.—Pierre Dennis Pit (Marihaye). Level, 600 ft. deep. Rock—Coal shales and grit; width of level, 5½ ft.; height, 6 ft.; area, 31 square feet; holes, 1¼ in. diameter; depth 6 ft. A second level 1,352 ft. deep; width, 7¼ ft.; height, 7½ ft.; area of face, 62¼ ft.; number of borers employed, 4; holes at bottom, 1¼ in. diameter; depth, 6 ft.; number of blows made by borer per minute, 250 to 300.

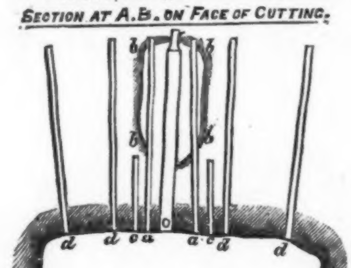
14.—Stahlberg Musen (Prussia). Sinking shafts and driving levels. Rock—Hard crystalline grauwacke and quartzite. Length of air pipes, 2,700 ft.; diameter of pipes, 2½ in.; sink, 8 ft. long and 5 ft. wide; area, 40 square feet; number of borers employed, 1; diameter of hole, 1¼ in.; number of holes bored per shift, 8; average depth of hole, 2 ft.; number of blows made by Sach's machine per minute, 300 to 400.

15.—Gouley Colliery (Aix-la-Chapelle.) Level, 1,380 ft. from surface. Rock—Hard sandstone and tough slate. Dimensions of level, 8 ft. by 8 ft.; area, 64 square feet; number of borers, 1; diameter of hole, 1¼ in.; number of blows made by Sach's machine per minute, 350 to 400.

FACE OF CUTTING.
30 HOLES.



SECTION AT A.B. ON FACE OF CUTTING.



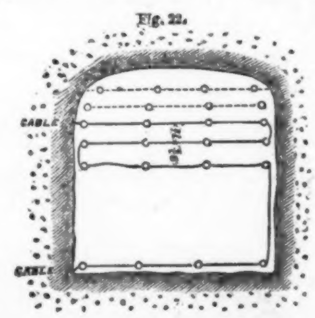
16.—Dryrook Iron Mine.—Sinking shaft and driving level. Rock—Magnesia limestone; level—width 6 ft., height 6 ft. 8 in.; area of forebreast, 40 ft.; number of borers employed, 1; number of holes in forebreast, 34; depth of holes bored on Brain's radial system, 3 ft. 1 in. to 4 ft. 3 in.; diameter of hole, 1¼ in.; number of blows per minute per Darlington borer, 400 to 500.

17.—Sir Francis Level (Yorkshire). Lime, marl, and hard grit; stone hard, with lines of cleavage crossing the lines of the holes; length of level, 4,400 ft.; forehead—height 7 ft., width 5 ft.; area of face, 35 square feet; number of holes per running fathom, 30; number of blows made by McKean borer, 500 to 600 per minute.

18.—Frederichsegen (Lahn Prussia). Rock—Coblenzer slates and quartzite. Adit level, 6½ ft. by 7 ft.; area, 45½ ft.; numberof holes bored in forebreast, 24; diameter of holes, 1¼ in.; depth of holes, 4½ ft.; number of borers simultaneously employed, 4; number of strokes per minute by the Dubois and François machine, 300.

19.—Mineral Mines (Wrexham). Rock—Mountain limestone, short, jointy, sometimes cherty, drusy, and vughy. (1.) Plat cut at the 200 yard level by means of a Darlington machine, mounted on a vertical stretcher-bar. (2.) Shaft sunk from 200 to 220 yard level, by means of a boring-machine, mounted on a horizontal arm, rotating on a vertical bar 12 ft. long; diameter of shaft, 8½ ft.; area of bottom, 56¾ ft.; number of holes in bottom of shaft, 36; depth of holes, 2½ to 3 ft.; diameter of holes at bottom, 1¼ in.; number of men employed, 9. (3.) A cross-cut (Fig. 23), 6 ft. 9 in. high by 6½ ft. wide; area of face, 40 square feet; number

Fig. 22.




of machines employed, 1-2; number of holes in forebreast, 26 to 28; average depth of holes, 34 in.; diameter of holes at bottom, 1⅛ in.; area of face to one machine, 40 square feet; average length of cut, 2 ft. 7 in.

| | | | | |
|---|---|---|---|---|
| Cut, | 10 | holes each | ........ 3 | ft. deep. |
| First square up, | 8 | " | ........ 2¾ | " |
| Second " | 8 | " | ........ 2¾ | " |
| Total..... | 26 | | | |
| Roof holes ... | 2 | " | ........ 3 | " |
| Total. ... | 28 | | | |

Cubic contents of lineal yard, 13 tons; number of men employed, 9; length of shift, 8 hours. Cut blasted as follows:—(1.) Cut or center, 10 holes. (2.) First square up, 8 holes. (3.) Second square up and roof-holes, 10. Dynamite consumed per lineal yard of advance in the cross-cut, 12 to 13 lbs.; number of advances made per week, variable; hindrances frequent, owing to influx of water, inadequacy of drawing-power, breakage of pump rods and shaft-gear; rate of driving, about *four* times greater than if done solely by hand-labor. Hand price, £9 per yard; machine price, £6 per yard.

20.—JOHANN COLLIERY (Prussia). Rock—Hard sandstone, sandstone schist; shaft 14 ft. wide, length 16¼ ft.; area of bottom, 228 square feet; average depth of hole bored in schist, 58 in.; number of machines employed, 6; total number of holes bored per metre of ground sunk, 20; number of men employed in sinking shaft, including laborers, 20 to 22; length of shift, 8 hours; average number of shifts worked monthly, 427; machine cost per metre sunk, 34s. 2d.; labor cost, including cost of timber, per metre sunk, £14 6s. 6d.; total cost, £16 0s. 8d.

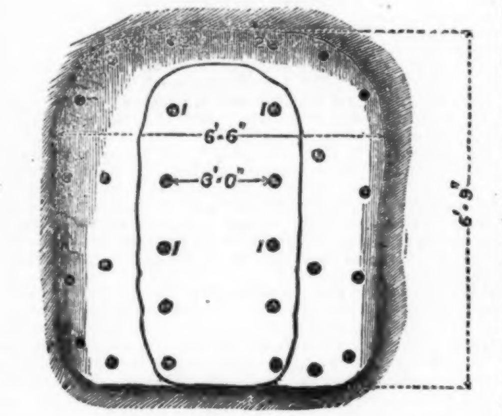
21.—MAESTEG TUNNEL (Bridgend). Rock—Pennant; height of level 9 ft., width 10 ft.; area of face, 70 square feet; contents per lineal yard, 270 cubic feet; number of boring machines employed, 2; diameter of borer cylinders, 4 in.; blows made by borer per minute, 300; diameter of holes, 2½ in., diminishing to 1½ in.; depth of holes, about 4 ft.; tool, T; number of holes bored in forebreast per advance, 16 to 20; diameter of air main, 4 in.; time required to bore holes, 4½ hours; time required for boring, blasting, and removal of stuff, 12 hours; number of advances made per 24 hours, 2; length of advance, about 4 ft.

22.—CWMBRAN (Newport). Rock—Coarse grain sandstone; height of level 7 ft., width 10 ft.; area of face, 70 square feet; contents per lineal yard, 210 cubic feet; number of boring machines employed, 2; diameter of boring cylinders, 4 in.; blows made per minute, 400 to 500; pressure of air required, 70 to 80 lbs. per inch; diameter of shot-hole, 2⅛ in., diminishing to 1⅛ in.; depth of holes, 2½ to 3 ft.; tool, thick chisel point; number of holes bored in face per advance, 10 to 12; number of cuts per 24 hours, variable; ground driven per week, 10 to 14 yards; length of level driven, about 1,000 yards; dynamite consumed per yard of ground, 20 to 24 lbs.

23.—DOLCOATH. Level, 1,884 ft. below the surface; dimensions, 6 ft. by 7 ft.; area, 42 square feet; number of Barrow machines employed, 1; borer cylinder, 3½ in. diameter; piston-rod, 2 in. diameter; length of machine from top to end of piston-rod, 3 ft. 4 in.; number of strokes per minute, 300; air-pressure required, 55 to 60 lbs. per square inch; number of holes in forebreast, 20 to 24; average depth of

Fig. 23.

26 TO 28 HOLES




holes, 20 in.; number of holes drilled in eight hours, 14; borer points, 1¼, 1⅛, and 1 in. wide; time occupied in boring, charging, and firing the holes, including removal of the debris, 10 to 12 hours; number of hands employed with machine, 3, or 9 per 24 hours.

24.—SOUTH CROFTY (Cornwall). Air compressor—cylinder 12 in. diameter, 18 in. stroke; steam cylinder, 14 in. diameter, and 18 in. stroke; air conveyed underground in pipes 2 in. diameter; air pressure required to run boring machine, 50 to 55 lbs.; one machine employed in the 205 fm. cross-cut; number of men employed 6, boys 3—total, 9 hands; dynamite consumed per lineal yard of ground, 25 lbs.; diameter of shot-holes, 1½ in.; length of hole, 2 ft.

APPROXIMATE MONTHLY COST OF WORK AS FURNISHED BY A CORNISH AGENT.

| | | | |
|---|---|---|---|
| 3 men, at | £5 0 0 | | £15 0 0 |
| 3 men, at | 3 10 0 | | 10 10 0 |
| 3 boys, at | 2 0 0 | | 6 0 0 |
| Labor cost | | | £31 10 0 |
| Dynamite | | £25 0 0 | |
| Coals, 10 cwts. daily | | 10 0 0 | |
| Grease, oil, fuse, etc | | 7 0 0 | |
| Smith cost, etc. | | 5 0 0 | £47 0 0 |
| Repairs | | | 5 0 0 |
| At 5 fms. monthly, £16 10s. per fm. | | | £83 10 0 |

[NOTE.—In the foregoing rough estimate no charge appears for enginemen.]

25.—CARN BREA (Cornwall). Level, 8½ ft. by 8½ ft.; area, 72 square feet; depth of level from surface, 1,356 ft.; air-pipes mainly 3 in. diameter; diameter of cylinders of boring-machines, 4 in.; number of machines running together, 4; pressure of air required, 40 lbs. per square inch; air compressor to run four machines, two cylinders each, 18 in. diameter, and 30 in. stroke; steam cylinders, 20 in. diameter and 36 in. stroke; sectional area of forebreast to one machine, 18 square feet; number of holes to a blast, about 18; depth of holes, 3 to 3½ ft.; diameter of holes, 2 in.; time required to put down 18 holes, 4 to 5 hours. The monthly cost of the work is not known, but the following rough estimate is furnished by a practical miner:—

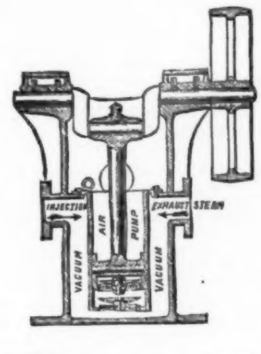
| | |
|---|---|
| 15 men boring and blasting | £76 0 0 |
| 2 men at engine | 7 0 0 |
| 2 smiths and boys | 10 0 0 |
| 2 fillers | 12 0 0 |
| Dynamite | 85 0 0 |
| Coal, 2 tons per 24 hours | 40 0 0 |
| Grease, oil, fuse, detonators, etc. | 25 0 0 |
| Repairs | 10 0 0 |
| Agency | 22 0 0 |
| Total | £287 0 0 |

Drivage four weeks, 14 fathoms, or cost $\left(\frac{287}{14}\right)$ £20 10s. per fathom.

26.—BALLACORKISH (Isle of Man). Rock—Tough, jointy clay-slate, with veins of quartz. Shaft: depth, about 70 fms. from surface; diameter, 10½ ft.; area, 86 square feet. Number of Darlington machines employed, 2. Area of shaft to one machine, 43 square feet; pressure of air required, 45 to 55 lbs. Number of strokes per minute, about 400; number of men employed, 9; length of shift, 8 hours. Number of holes bored in bottom of shaft, 22 to 24; depth of holes, 3½ to 4½ ft.; diameter of holes, 1¼ to 1 in.; depth of sink, about 4 ft. Proportion of time of boring to time of other operation, 1 to 5. Hand price, £31 per fathom; machine price, £13 per fathom. Speed, 2 fathoms weekly; machine speed, 5 times greater than hand speed.—*Mining Journal.*

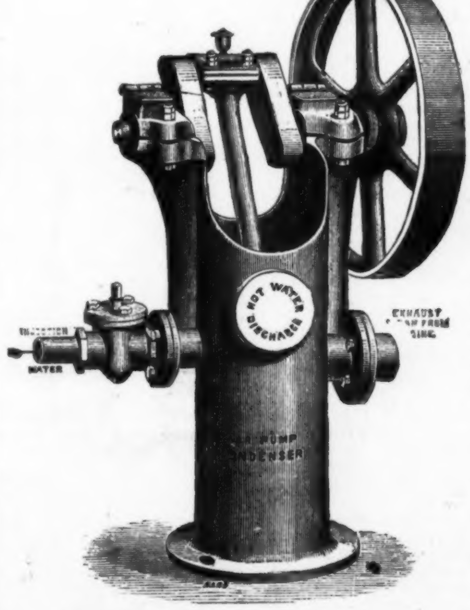
## VERTICAL AIR-PUMP CONDENSER.

IT has been the experience of almost all manufacturers who use steam power that, owing to the extensions of their premises and additions to their machinery their engine-power has been rendered inadequate to their requirements; and supposing the engine to be a high pressure non-condensing one working expansively, a common way of increasing its capability is to alter the valves so as to cut off the steam later in the stroke, and this is sometimes done to the length of reducing the expansion to almost *nil*. Practiced engineers look very dubiously on this method; the fact, however, of its being sometimes the lesser of two evils accounts




for its adoption; but its extreme wastefulness cannot be too strongly insisted on. Bearing in mind that our remarks apply to non-condensing engines where there happens to be a moderate supply of water at command, the best alternative is by far to attach an air-pump and condenser, and utilize the vacuum obtained, working the engine as a condensing one.

Even where the engine is fully up to its work, the addition of a condensing apparatus, if it can be cheaply made, is advisable on the ground of fuel saved, the economy in which can easily reach the respectable figure of 25, and more, per cent. The air-pump condenser represented in the engravings has been introduced to supply the want alluded to. As will be seen on reference to the sectional view, its construction is extremely simple and well designed. It may be placed in any convenient situation irrespective of the engine, and the most suitable means employed to drive it; for instance, a belt from a line of shafting or from the




IMPROVED AIR-PUMP CONDENSER.

position of the engine shaft itself. The injection water is led in through a sieve, placed as shown, on the flange of the inlet pipe, and the exhaust steam is brought in as indicated in the section. A very useful point, and one worth attending to, is that the exhaust steam from a number of small engines may be led to one of these condensers placed most conveniently with respect to them, and thus, by the addition (very often easily made) of a single inexpensive apparatus, a number of non-condensing engines may be converted into condensing ones, with either an increase of driving power or a saving of fuel, as may be most desirable. A steady vacuum is obtainable in these machines, ranging from 12½ lbs. to 13½ lbs. per square inch; and Messrs. Tangye, London, supply them of several sizes, suitable for all engines of from 5 in. to 26 in. in diameter of steam cylinder.—*Textile Manufacturer.*

## THE HAXALL MILLS, AT RICHMOND, VIRGINIA.

No Southern State has displayed such energy in recovering from the prostration caused by the war as Virginia. Within the past few years, manufactures of every description have sprung up, and the foundations of permanent prosperity laid broad and deep. The milling interest of the State has always been considerable, and though the larger part of the Virginian mills was destroyed by the chances of war, public and private enterprise has been such that many of them have been rebuilt, and milling is once more a leading branch of industry in the Old Dominion. Richmond has for many years been noted for the size of its flour mills and the excellence of the flour produced by them. The foreign demand for Richmond flour has been immense, and the shipments of flour from that city and its suburbs to South American ports alone frequently amount to 10,000 barrels per month. Pre-eminent among the mills of Virginia, and in the first rank of those of the world, are the famous Haxall Mills, of Richmond, of which it is the purpose of the present article to give an illustrated description. The name of this establishment is doubtless familiar to our readers, and its size and reputation, coupled with its long and honorable history, make it an object of interest and just pride to every miller in the land.

As early as 1808, Mr. Philip Haxall and his brother, William Haxall, purchased the site of the present mills, on which there was then standing a grist mill known as the "Columbia Mill." Here in 1809 they erected the establishment which was subsequently called by their name; and from this beginning, by successive additions and constant improvements, have arisen the vast brick structures which are to-day a monument to the perseverance and business capacity of its founders and of its present owners. The style of the firm has varied as new members have been added; but the name of the original founders has always been retained through all the different changes. In 1858 Mr. Lewis D. Crenshaw, Sr., became a member of the firm, and the style of the firm was changed to Haxall, Crenshaw & Co. Mr. Philip Haxall, Vice President of the present company, became a member of the firm in 1865. In consequence of the death of Lewis D. Crenshaw, Sr., the firm of Haxall, Crenshaw & Co., was dissolved June 30, 1876, and the Haxall-Crenshaw Co. formed, with R. Barton Haxall as President, Philip Haxall, Vice-President, and Lewis D. Crenshaw, Jr., Secretary and Treasurer. The Haxall Mills have been twice reduced to ashes, once in 1830, and again in April, 1874; yet, notwithstanding these reverses, they have been rebuilt each time with additions and improvements. In 1831, the year in which the mills were rebuilt after the first fire, Mr. Philip Haxall, the founder of the establishment, died, and Mr. R. Barton Haxall, the President of the present company, became the head of the firm and took control of the mills, being then 26 years old.

Such is a brief account of this historical mill. The present buildings, which were erected in 1874, stand at the foot of 12th street, between the canal and James River. The property has a frontage of about 1,000 feet on the James River, and includes about seven acres. The principal buildings are the flour mill proper, the wheat-house, general storehouse, corn mill, blacksmith and wheelwright shops, millwright shop, cooper shops, residence of the millers, and a large brick stable.

The wheat-house which adjoins the mill is eight stories high, with a storage capacity of 70,000 bushels, 10,000 bushels being frequently received in the course of one day. Here the wheat is received, weighed, graded and stored in various garners according to variety and grade. In this building, also, the wheat is cleaned, and, after cleaning, each variety is conveyed to the different garners of the mill as it may be needed. Among the wheat-cleaning apparatus are the following machines: 2 separators, Nos. 3½ and 5, manufactured by the Barnard & Leas Man'f'g Co., Moline, Ill., on the 7th floor; 2 California Smutters and Separators, No. 3, made by M. Deal & Co., Bucyrus, O., on the 6th floor; 2 Empire Decorticators, on the 5th floor; 2 smutters, a No. 1 Richmond, made by Wm. Richmond, Lockport, N. Y., and a No. 5 Victor, made by Barnard & Leas, on the 4th floor, and 2 Becker Brushes, made by the Eureka Man'f'g Co., Rock Falls, Ill., on the 3d floor. These machines are placed in the order named, one above the other, and the wheat passes through them from the top story down, so as to clean two streams of wheat at the same time. Large air chambers are attached to the cleaning apparatus, and into them is blown the refuse, which is all sold. In this same building are four large grain scales holding 150 bushels each, and a corresponding number of elevators.

In one of the storehouses, which is 70 by 100 feet and six stories high, are located the various offices, a large scale, etc., the remainder of the space being devoted to the storage of flour, of which it can store 15,000 barrels. The firm has recently erected another storehouse 80 by 52 feet and seven stories high, exclusive of the basement, each story being 12 feet high. Two stories are for flour, with a storage capacity of 3,000 barrels each; one for barrels, capable of holding 9,000 empty barrels, and the remaining four for millfeed, each story holding 150 tons.

The flour mill proper is 85 by 60 feet and eight stories high. It contains 42 run of burrs, 20 of which are four and 22, four and a half feet in diameter; or a greater number of burrs than any other mill in America. It can turn out conveniently 1,200 barrels a day, though the capacity can easily be worked up to 1,500 barrels; and the annual production is over 200,000 barrels, which requires about 1,000,000 bushels of wheat. Besides the burrs, there are in the mill building 8 Great Western Bran Dusters, made by Stephen Hughes & Co., Hamilton, O., on the 6th and 7th floors; 12 Lacroix Purifiers on the 3rd floor; and 12 dusters, each 6 feet long, on the 4th floor. On the 5th, 6th and 7th floors are 122 bolting reels, each 15 feet long and 30 inches in diameter, with hollow iron shafts and arms. In additon to the machinery just enumerated, there is in the mill a large amount of improved machinery and appliances such as are found in the first class mills of the day. Nothing is stored in this building, the grain flowing in as it is needed, and the flour rolling out as fast as it is packed into either of the two storehouses, having a combined capacity of 22,000 barrels.

The corn mill has six run of Esopus stones, with a capacity of about 1,000 bushels of corn per day. Only carefully selected white Southern corn is employed, and an article is produced for which there is a large demand both in Virginia and North Carolina.

The mill and its appurtenances are all driven by water power. The motive power is furnished by six over-shot wheels, each 18 feet in diameter, which together supply 300 horse power, and three turbines. One of the turbines, a Leffel wheel, supplied by Messrs. Poole & Hunt, of Baltimore, Md., drives all the wheat-cleaning machinery; another one, a Burnham wheel, made at York, Pa., drives the corn mill,

and the third turbine, made at Baird's Foundry, Richmond, drives the machinery in the millwright and repair shop.

When rebuilt in 1874, several mill-furnishing firms were levied on to supply the machinery for this establishment. Mr. Samuel Carey, of New York, supplied the burrs and bolting cloth; and above the grinding floor the machinery was chiefly supplied by Messrs. Jno. T. Noye & Son, of Buffalo, N.Y. The belting throughout the whole establishment was furnished by J. B. C. Hoyt, of New York City, and the heavy gearing by the Tredegar Co., of Richmond. All the heavy timber was brought from South Carolina. Mr. Ira Wescott, of Jno. T. Noye & Son's establishment, was the principal person outside of the owners concerned in planning and arranging the mill.

We have endeavored in the above paragraph to convey some idea of the extent and arrangement of these famous mills. To give a detailed description of them would require more space than we have at our command. It is only necessary to say that the mills are equipped in the very best style and to suit the requirements of modern milling. The brands of flour turned out by this establishment which are best known are "Patent Family," "Haxall," and "Crenshaw," for family use; "Padeiro," extra; "Tremont," superfine; and "Orange," fine. Some of these brands, according to the demands of various countries, find their way to the West Indies, South America, Africa, Canada, Great Britain, the Continent, and almost every part of this country. One evidence of the excellence of the flour made by the Haxall Mills is found in the fact that their name has been appropriated by other manufacturers to an extent that would hardly be credited. Such was the reputation attained by the Haxall brands even as early as 1858, that by the terms of partnership formed between R. Barton Haxall and Lewis D. Crenshaw the name was agreed to be worth $50,000.

Of the gentlemen comprising the Haxall-Crenshaw Co. it is scarcely necessary to speak. Mr. R. Barton Haxall has been the head of the firm for many years. Mr. Philip Haxall was chosen by the last convention as Vice-President for Virginia of the Millers' National Association, and a member of the Executive Committee. They are all gentlemen who possess the same financial and executive ability that have characterized the firm for three-quarters of a century, and in their hands is safe the reputation of the Haxall Mills.—*American Miller.*

## COMPOUND ARMOR PLATES.

For some months past attention has been drawn to the possibility of the reopening of the question of guns *versus* targets. This anticipated state of matters is being brought about by the introduction of some novelties in the construction and manufacture of armor plates. The Heavy Gun Committee have long been pursuing investigations with regard to compound armor plates, that is, plates having steel faces and iron backings. The necessity for having a substitute for iron, and which substitute should not be steel pure and simple, was made apparent at the celebrated Spezzia armor-plate trials, in which some steel plates defined the 100-ton gun, but were broken up by 10-in. and 11-in. guns. At Shoeburyness, early in the year, and again about a month since, experiments were made with plates of compound construction with a certain degree of success. In the first instance the plate tried was one produced by Messrs. Cammell & Co. under the patent of Mr. A. Wilson. In the second and more recent trial a similarly constructed though differently manufactured plate by Sir John Brown's firm was tested. More recently still, namely, on Tuesday last, a series of trials were carried out by the Admiralty at Portsmouth with compound armor plates manufactured by Messrs. Cammell & Co., and with a plate of peculiar pattern designed and made by Sir Joseph Whitworth. There was a large gathering of naval and military officers, including the heads of various Government departments interested in the question at issue. The experiments took place on board the Nettle, and were carried out under the direction of Rear-Admiral Boys, Director of Naval Ordnance; Captain Herbert, of the Excellent, having charge of the firing.

The plates experimented upon were four in number. There was first Sir Joseph Whitworth's plate made of his compressed steel. Next was a sub-carburized steel plate by Messrs. Cammell. The third was a steel-faced iron plate by the same firm, and the fourth a plate, also by Messrs. Cammell, in which the steel is sandwiched in between two plates of iron. All the plates were 9 in. in thickness. The Whitworth target measured 6 ft. 8 in. wide by 6 ft high, and consisted, as stated, of a plate of compressed steel, in which about fifty hardened screw plugs were inserted. The plugs are placed so closely together that a projectile cannot do more than slightly penetrate the plate without coming in contact with some of the plugs. Sir Joseph thus claims to obtain a maximum of strength with reduced thickness of armor. The body of the plate is made of steel having a tensile strength of about 40 tons per square inch, while the plugs are formed of steel possessing a tensile strength of about 100 tons per square inch. By this device it is assumed that the shot will be broken upon impact, a further advantage being that the plug-holes will arrest any cracks that may be started in the body of the plate. The heads of the bolts for holding the plate to its backing were inserted in and held by some of the screwed plugs.

Messrs. Cammell's sub-carburized plate was 9 ft. 9 in. wide by 7 ft. 9 in. deep. and weighed 11 tons 4 cwt. It is a solid steel plate in which the carbon is so low—being reduced to .13 per cent.—that the metal approaches in character to wrought iron. The object in view in producing this metal was to obtain a steel plate which should offer a greater resistance than iron to penetration and which yet would not star under impact. The combined iron and steel plate—that faced with steel—was intended to resist penetration by destroying or breaking up the projectile on impact. It was 9 ft. 9 in. wide by 7 ft. 1¼ in. deep, and weighed 11 tons 4 cwt. It consisted of a steel face 4 in. thick, containing .64 per cent. of carbon, and having a backing of 5 in. of wrought iron. The sandwiched steel in iron plate measured 8 ft. in width and 5 ft. 11 in. in depth, and weighed 7 tons 16 cwt. It was composed of a face-plate of iron ¾ in. thick, a central plate of steel 6¼ in. thick, and a back plate of iron 1¾ in. thick. The steel contained .57 per cent. of carbon, and, like that in the previous plate, was considered hard. In order to have a basis of comparison a solid wrought-iron plate made by Messrs. Cammell was fired at on the 12th of October last. This plate was 9 ft. 9 in. wide, 7 ft. 9 in. deep, and of the same thickness as all the others, namely 9 in.

The compound plates were made under the patent process of Mr. Alexander Wilson, which consists in heating the iron plate in a specially constructed furnace to a certain degree of redness, and, while in the furnace, in pouring upon it the molten steel to the required thickness. The steel has a much higher temperature than the iron plate, that of the latter being comparatively low. The excess of heat in the steel beyond the welding temperature of the iron serves to bring up the surface of the iron to a welding heat. The carbon in the steel carburizes the iron to a depth of from ¼ in. to $\frac{3}{16}$ in., thus forming a zone of mild steel between the hard steel and the iron, which constitutes an inseparable weld. The small plate which was tried at Shoebury gave remarkably good results. Messrs. John Brown & Co.'s process differs slightly in some of its details as regards manufacture, but the principle involved is the same. In the case of the sandwiched steel and iron plates, the iron plates are retained in a vertical position, and the steel is poured in between them. Messrs. Cammell & Co. have also a patent for the manufacture of their sub-carburized plates.

In the experiments on Tuesday last the plates were all held to their timber backing by means of 2¼ in. steel bolts of two different patterns, the designs for which were furnished by the War Office and the Admiralty respectively, the bolts being manufactured by the makers of the plates. The threads were in each case *plus*, that is, extraneous to the surface of the bolt and not cut into it. The War Office bolt has a spherical nut and a coiled washer arranged on the ball and socket joint principle. The Admiralty bolt has the ordinary India-rubber navy washer and hexagonal nut. The bolts were all put in from the rear of the plates, entering the plates to a depth of about 2½ in. Messrs. Cammell's plates were secured each with equal proportions of the War Office and the navy bolts, while the Whitworth plate was held wholly by bolts of the navy pattern. The plates were fixed against a substantial timber framing and the gun used was a 12 ton 9 in. muzzle-loading rifled gun of the Woolwich pattern. Battering charges of 50 lbs. of pebble powder were fired with a chilled Palliser 250 lb. shot. The muzzle velocity was 1,420 ft. per second, the muzzle energy 3,496 foot-tons, and the range 30 ft. Three shots, forming a triangular diagram, were to be fired at each plate, the points of impact being about 2 ft. apart. The firing was point blank at right angles with the face of the targets.

The results of the firing on the wrought-iron plate—and which was to be taken as a basis for comparison—were the perforation of the plate by one shot, and a considerable bulging of the rear by the other two which failed to penetrate it. The firing against it was conducted under the same conditions as on last Tuesday. On the latter occasion firing was first commenced against Sir Joseph Whitworth's plate, and at the first round the shot penetrated 4.1 in., at the second 2.85 in. The penetration at the third round could not be ascertained, as the shot was broken up and the point remained imbedded in the plate. The plate resisted the shot well, but owing to the absence of oil-toughening—Sir Joseph not having a tank sufficiently large for the plate—the tensile strength was lower than it otherwise would have been, and the plate was much starred. The plugs certainly successfully performed their allotted task of breaking up the projectiles, but they appeared to assist in cracking the plate also.

The next plate tried was that made of Cammell's sub-carburized metal. The plate did not start, but it split, each successive round further developing the cracks. The steel was of very high quality and the plate came out from the ordeal remarkably well. The steel-faced plate was next tried, with results greatly inferior to those obtained with the small plate at Shoeburyness. The first shot effected complete penetration, and was estimated to have gone about 15 in. into the wood backing. The second shot went through about 9 in. into the backing. The plates, moreover, showed marked signs of defective welding, and there were appearances of burning in the metal. The conclusion arrived at was that the manufacturers had been obliged to push on too quickly in order to produce the plates within the time specified by the Government. Hence defects had crept in, and therefore the system was not fairly represented. The third round was not fired. The fourth and last target was the steel sandwiched between iron plates. The penetration at the first round was 6.75 in., the second round produced a long crack, while the third round punished the plate severely. Here again imperfect manufacture was apparent, the result, as before, of the manufacturers having been overtasked on having to produce the plates to the order of the Government within a comparatively limited period.

The general results of these experiments show the advantage of placing the iron behind the steel to arrest cracks. This result was very marked in the case of the sandwiched plate, the cracks in which at the first round were restricted to the center layer, which was the steel. It is, however, palpable that further experiments will have to be made before the compound armor-plate system can be considered worthy of adoption. It should also be borne in mind that the conditions of firing were such as could hardly occur in actual warfare, the gun being aimed point blank and at a range of only 30 ft. With time and care, and by the light of Tuesday's experiences, it may be that we shall ultimately find, either in the compound system of Messrs. Cammell, or in the plugged arrangement of Sir Joseph Whitworth, an approximate solution of the armor-plate question.—*Engineering.*

## THE EMMA MINE.

The renewal of shipments of ore from the celebrated Emma Mine will naturally cause all who are or have been shareholders in the now almost defunct English company formed for working it to consider anew the value of the property they so thoughtlessly threw away. Throughout all the clamor as to the alleged deception practiced in the transfer of the mine to the English shareholders, as well as since, it has invariably been asserted in the *Mining Journal* that if any reliance was to be placed in the opinion of practical miners who had visited the property, but were pecuniarily disinterested in the result of the working, the Emma was unquestionably a good mine, and worthy of development. That the English paid a large price for the mine is admitted, but that price was known to the whole world before the public invested one penny, so that the capitalists who speculated were like children who spend their money in coveted toys, then cry because the money is gone, and smash the toys to vent their spite. As the London Emma shareholders have now neither the capital invested nor the property, they can dispassionately consider their position, and estimate the advantages of patience and common sense in the conduct of mining operations as compared with rashness and the love of litigation. From the time the Emma Mine passed into the hands of the English company, exploration (the one thing necessary to secure permanent profits in mining) was entirely neglected, and a system of careless management was carried on which in a few months would bring into the winding-up courts even such properties as Cape Copper, Linares, Fortuna, Pontgibaud, and others equally successful. The London Emma shareholders appeared to suppose that even ordinary business energy and judgment were unnecessary, and that nothing had to be done but receive the periodical dividends forever. Such marvelous benefits are not secured in mining any more than in other business.

And the puerile simplicity of the shareholders is the more apparent when it is considered that the fact that the property was being ruined by bad management in the shape of neglect to provide for the future was well known to the shareholders long before it was too late to retrieve their position, and when even a small outlay upon exploratory work would have made the Emma property rank at least with the Richmond or any other American concern on the English market as a permanently profitable undertaking. Foremost in his reiterated assertions that the Emma was being crippled through inattention to development was an esteemed correspondent of the *Mining Journal*—Mr. Henry Sewell—and the few of his facts republished last week suffice to show how small a drag upon the returns from the mine would have sufficed to do all that was necessary. Well may Mr. Sewell wish the readers of the *Journal* to be reminded how often he requested Mr. A. MacDougall to accept the £50,000 offered to the English shareholders by Messrs. T. W. Park and Albert Grant to work the mine. It should be remembered that this sum was only to be returned in case the mine paid for it—that is, three-fourths of the net proceeds were to be for the English shareholders, the remaining one-fourth to be devoted to the payment of the £50,000. Mr. Sewell thinks there is no doubt that the shareholders have been badly directed in their lawsuiting business; and he mentions that he predicted to Mr. MacDougall that he would never gain this suit in America, which was a greater reason that the £50,000 should have been accepted.

The character of the rock in which the Emma Mine is situated rendered exploration of even more than usual importance; and hence Mr. Sewell remarked in his pamphlet on the Emma (published when there was still time to have avoided the subsequent litigation, which very properly deprived the company of the mine altogether) that, owing to the geological features of the district, and especially of the nature of the rock between which the ore body was found—stratified limestone—the future prospects, assuming ore to continue, would entirely depend upon the due working of the mine, so as to have proper reserves, and the due arrangements for development, such as provision for ventilation, and proper machine power for pumping and raising the ore, and thus pushing on of exploratory works, so as to find further bodies of ore both horizontally and toward depth, as the then existing ore body in the deepest part of the mine showed signs of compression, and so might be expected soon to be reduced, and to go off to a mere thread. Mr. Sewell was well aware that limestone formations, such as are found at the Emma Mine, and in which he had some years' experience in Spain, Chili, Peru and Mexico, and in which some of the richest ore bodies have been found, were often affected by such compressions, but so long as there was a continuance of the vein, however thin, there was a fair prospect of its again coming out, and producing as valuable a body of ore as was then being worked. He mentions that even in the celebrated Potosi Mines, which for 246 years yielded the Spanish Government £800,000 per annum as royalty, the veins were constantly being affected by these compressions, varying from several yards to the thickness of a penknife blade.

It is but justice to Mr. Sewell to state that his views appear to be now receiving full confirmation, although at the time he wrote they were ignored, from the circumstance, probably, of his opinion being diametrically opposite to those of Mr. Warren Hussey, one of the original venders and a large local shareholder; of Mr. Silas Williams, the mine agent; of Mr. George Attwood, the mine manager; of Mr. Clarence King, a celebrated American geologist; Prof. Murray, a mineralogist; and Mr. John Longmaid, a mining engineer who condemned a neighboring mine as containing no ore worth raising, though the succeeding proprietor quickly raised 2,000 tons of silver-lead ore, and continued to turn out regularly 300 tons per month with good profit. That Mr. Sewell wrote from actual knowledge, and not from mere hypothesis, seems evident, since in July, 1872, he made an affidavit in one of the local courts that the Emma was a bed vein, and that it would be proved to be the same as the Flagstaff, Vallego, and several other mines in the district. The correctness of this has now been proved by subsequent events, for the Emma bed vein is continuous for about 10,000 feet, and is not an isolated body of ore, as was supposed by some. Upon these facts Mr. Sewell very reasonably argued that the length of the Emma vein having been proved by actual work of the mines that are situated on the same vein for a distance of 10,000 ft., such as the Flagstaff, Vallego, and others, to be a master vein, it is but reasonable to suppose that new ore bodies will be found in depth as well as in length, as already stated. Mr. Sewell explained that the Emma at the time he examined it exhibited distinct and marked characteristics of a well-defined segregated strata vein; the footwall has a regular pitch into the hill of about 45°, and a course in a northwesterly direction, corresponding with the footwall found in the Flagstaff Mine, which development will, in his opinion, prove to be identical with that of the Emma. The accuracy of Mr. Sewell's views will certainly add to his already high reputation as a mining engineer, and although the Emma has been lost to the English capitalists, a compensation may be found in the neighboring mines which are still in English hands.—*Mining Journal.*

## A SUCCESSFUL SMALL-SIZED CATAMARAN.

*To the Editor of the Scientific American:*

GENTLEMEN—I saw in the SCIENTIFIC AMERICAN SUPPLEMENT No. 106 an article, from "Paddlefast," on catamarans, in which he says "that a length less than 25 feet is not advisable for these boats." In answer to this, I would like to state my experience with one 16 feet in length. I built it last spring as an experiment; it was a very rude affair, with old sails entirely too small. With it I beat the fastest boat in Stratford, Conn., harbor. She was also sailed in Stamford, Conn., harbor, and beat one of their fast boats; this was done with three persons on board, aggregate weight about 400 pounds. You see this is about the same weight that "Paddlefast" claims his 25-foot boat will carry with safety. She is a good sea boat, and has been sailed in some pretty rough weather on Long Island Sound.

I was led to write this article, thinking there might be young amateur boat-builders who would be deterred from building a catamaran by supposing that one less than 25 feet would not be advisable; also from the fact that one of the latter size would be too expensive. I propose this coming spring to build three more on an improved plan, which, I expect, will give greater speed, comfort, and safety. I shall then be prepared to give the cost of building, which, I am sure, will come within the means of many a young man's slim pocket-book. Yours truly,

Bridgeport, Conn., Jan. 16th, 1878. F. R. SAMMIS.

## DESIGN FOR DWELLING.

OUR engraving represents a design for a private dwelling, at Syracuse, N. Y., by Archimedes Russel, of that city. The structure is of best front brick, erected at a cost of $12,000. The drawing is from the *Amer. Arch. and Building News.*

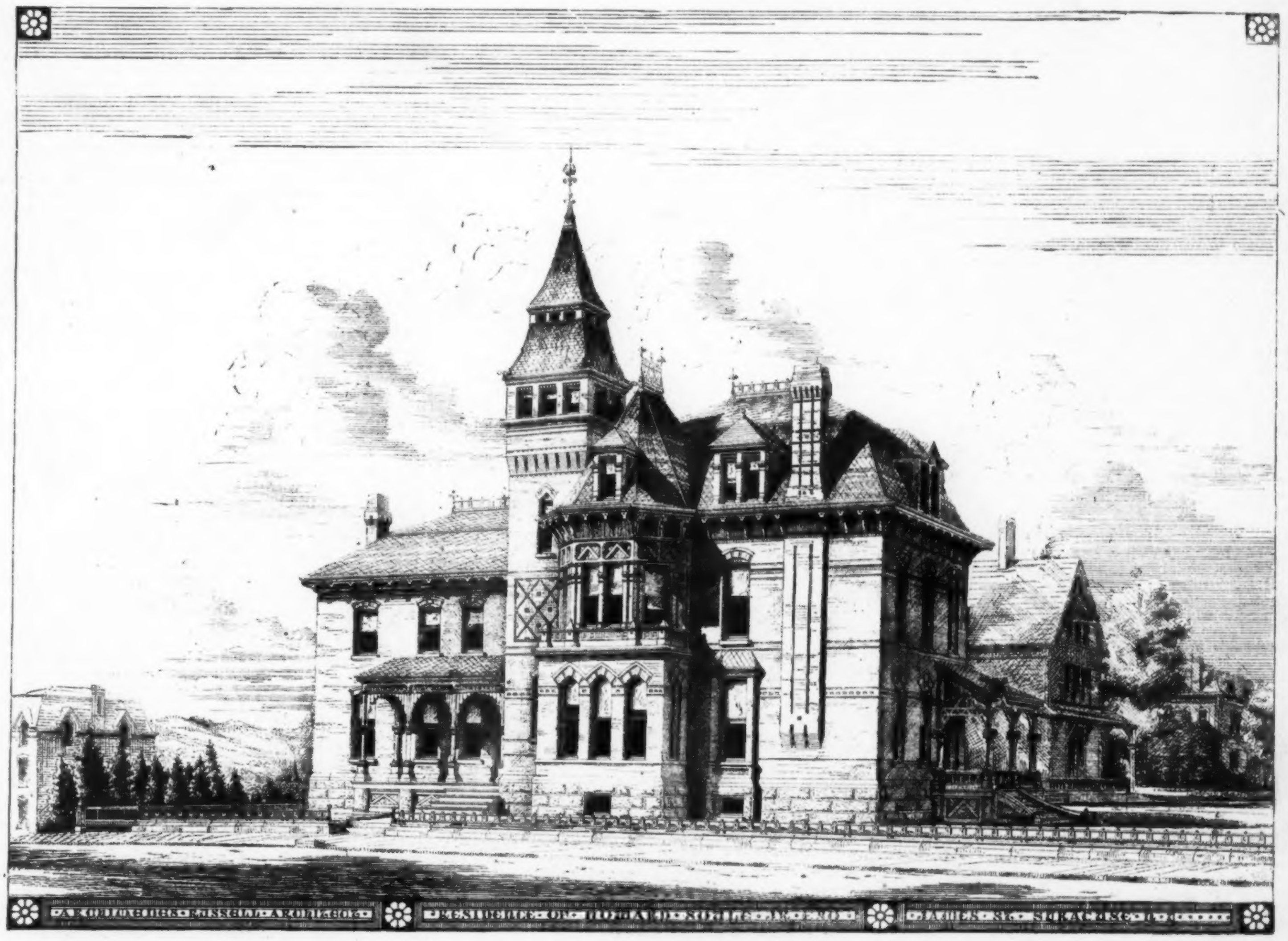
## THE TECHNOLOGY OF THE PAPER TRADE.*

By WILLIAM ARNOT, F. R. S.

LECTURE I.

*Introductory, Historical, Descriptive and Statistical.*

THE absence of authentic records has been the cause of much speculation as to when, where and by whom paper was first made. The Chinese people have, however, generally been credited with its discovery, and there is little room to question their claim. We find that this peculiar people have in many of the arts been at work and made discoveries centuries before us. The state of perfection to which they have brought the manufacture of paper, in the absence of the elaborate machinery with which we are familiar in the modern process of paper-making, is something marvelous, and the great variety of purposes to which it is applied by them is not less wonderful. Articles of furniture and clothing, and many other useful appliances, are made from this material by this industrious though curious people. We do not purpose to go into the history of the writing materials in use prior to the discovery of the process of paper-making. It may be necessary, however, to state that all the tablets, leaves and parchments in use in remote ages were natural productions, whereas paper, properly so called, is eminently artificial. The tablets of stone and of wood, the leaves of



the papyrus, the bark of the mulberry and other trees, the skins and other portions of animals, although prepared for this special purpose by various processes, were all strictly natural products, and could not in any case be regarded as artificial.

Paper, taking the description given by a recent writer, is an aqueous deposit of any vegetable fiber, radically different in its structure from all bodies formerly used for writing upon, being a highly artificial material and having no resemblance in its texture to any natural substance. It is probable that paper, bearing an essential resemblance to this description, was made about the seventh century. One writer mention as date 700 years prior to this, about the beginning of the Christian era, but the earliest reliable accounts we have regarding the material date from the beginning of the 10th century. About the beginning of the 14th century we have fuller accounts of the process, which, by that time, had no doubt developed considerably. A century later we find paper mills at work in England, under royal patronage, while in Scotland, where the trade now flourishes, it was not till toward the end of the 17th century that the first mill was established.

The early history of the process of paper-making is, no doubt, interesting, but the records regarding it are so meager and conflicting that we fear the practical end which these lectures are intended to serve would be but little advanced by even the most elaborate historical disquisition. That being the case, we shall only consider the history of the art in its more recent developments, so far as is necessary to enable us to appreciate the ingenuity and beauty of the processes at present in use.

Until 1860, although many fibrous materials had previously been experimented upon, rags of various kinds may be said to have been exclusively used for the production of paper pulp. In that year, however, esparto grass clearly established its claim as a practical and abundant source of fiber. Since then its use has been very largely extended, and at present much more paper is produced from it than from rags. For the finer and stronger classes of paper, however, rags are still used, either by themselves or mixed with esparto, and it is probable they will always hold the foremost place, both on account of the strength of their fiber and the percentage of yield. This last feature of rags is of course due to the circumstances that almost all the extraneous matters originally associated with the fiber have been removed by the processes to which the raw materials were subjected, when being prepared for their first manufacture into linen and cotton goods.

The process of reducing rags to the condition of pulp was, up to the middle of the last century, most tedious and laborious. The chemicals which now play so important a part in the process of paper-making had no place in the paper mill, indeed bleaching powder was yet to be discovered, while caustic soda was only known as a chemical curiosity. The rags were first cut and sorted, then soaked with water, and put aside in heaps to ferment or rot. In this condition they lay for from five or six days to as many weeks, being turned at intervals to prevent overheating, and also to secure a uniform result. No doubt the action which developed in these rag heaps was a species of fermentation, during which the glutinous matters inherent in them were changed in their nature, and made more easy of removal in the after stages of the operation. If care had not been exercised, and had this process been allowed to go on after the gluten and fat had been destroyed, the cellulose or fiber would undoubtedly have shared the same fate; a certain degree of skill was, therefore, necessary to the proper carrying on of this process, crude though it may seem.

A copious washing followed the rotting process, as it was called, after which the process of pulping was conducted in the following manner: The implement employed may be regarded as a species of mortar with a tight-fitting pestle or stamper working in it. The mortars were constructed of stone or wood, and the stampers were moved by levers actuated by projections fixed on the water-wheel shaft. A charge of rags for one of those mortars was about 3 lbs., and it took about twenty-four hours to complete the operation. Under this process there was no cutting or tearing, consequently the fibers were long, and the paper so produced was of great strength. To keep one of the largest of our modern paper-making machines at work no fewer than five thousand of these mortars would be required.

The pulp having been thus prepared was diffused through a large quantity of water in a vat, and kept uniform by agitation. From the vat the pulp was lifted on a series of moulds, each of which represented a sheet of paper of some definite size, duly christened with some antique name, such as "Antiquarian," "Double Elephant," "Foolscap," and so on. By a dexterous shake, the fiber was caused to settle down uniformly, and closely interlaced over the entire surface of the mould, while the water passed through the interstices of the wire cloth of which the mould was constructed.

From the mould the paper, which may be said to have been now formed, was placed between layers of felt, pressed by means of a hand screw press, so as to remove as much of the moisture as possible; then removed from the felts, and pressed again; and, finally, it was dried, sized and calendered. The hand process, as at present conducted, will be more fully explained and illustrated as we proceed.

The simple mortar and stamper, already described, seem to have been improved upon previous to the introduction of the beating engine, to which we are about to refer. Metal plates, with some sort of teeth, were introduced, and two stampers, rising and falling alternately, instead of one; so that the operation was more rapid and uniform, and a certain amount of cutting or tearing effected. The rags, too, seem to have been rotted in chests, or cases, which was, no doubt, a refinement; but it does not appear that any important improvement resulted from this addition to the plant of the paper mill.

About the middle of the last century a great stride was made, when the beating-engine was invented. It is to Holland we are indebted for this important improvement, and by the name of the "Hollander" the engine was long known. Although tons could be pulped by this machine, as compared with cwts. by the old method, a considerable period elapsed before it was fairly accepted by the papermakers.

The beating-engine may be briefly described as an oblong tube or cistern, with a partition running along the center lengthwise, to regulate the flow of the stuff. At one side of the partition, at the bottom, is fixed a set of knives, with the edges looking upward, while over these revolves a drum or roller, in which a second series of knives are fixed. Between the two sets of knives the rags, which are immersed in the water which fills the engine, are drawn, and, as the roller revolves rapidly, the cutting and tearing action is great, and disintegration speedily effected.

About fifty years after the invention of the "Hollander," alkali began to be employed for boiling the rags, and the rotting process was entirely superseded. Commercial caustic soda, which is now so extensively employed, was not known till long after this time, so that caustic lime (lime shell) was used either by itself or along with carbonated alkali, which it, of course, causticized. At first both the agents were put into the boiler with the rags, but in course of time a great refinement was effected; the caustic soda liquor being prepared in a separate vessel, the lime allowed to deposit, and the clear liquor alone run into the boiler.

Boiling seems to have been practiced to some extent previous to the introduction of chemical agents, this being done in open caldrons with direct fire heat. But the rags suffered in this process, those in immediate contact with the boiler getting burned or singed. To obviate this steam was ultimately introduced, first by a simple pipe or coil, and afterward by what are called vomiting tubes. Little or no pressure was at first put upon the boilers—indeed, from their construction they could not stand much pressure—but we find in recent times many boilers working under a pressure of 30, 40, and even 60 lbs. per square inch.

Almost simultaneously with the introduction of soda, which in after years made the use of many other fibrous materials besides rags possible, artificial bleaching agents began to be introduced. At first chlorine in its gaseous and simplest form was used; but this was dangerous and troublesome in its application, and expensive in production, and ere

* Journal of the Society of Arts.

long it gave place to the admirable invention of bleaching powder.

Paper beautifully uniform in texture, and as white as snow, was now not only possible, but easy of attainment. Still, however, the production was limited, each sheet having to be made by itself. Machinery had revolutionized one department of the process, and made the production of pulp easy and rapid; the disintegrating part of the work was now nearly perfect, but the building up of the fabric was slow and laborious, the nimble fingers of the Fourdrinier machine not having yet begun to weave the delicate fabric.

In 1799 the dawn of a second revolution appeared, when Louis Robert exhibited his model of a machine calculated to make paper in a continuous web. The germ of this invention was, like those of most other great discoveries in mechanics, developed in the midst of many difficulties, and its growth into the perfect piece of mechanism which it is to-day was slow and labored. Unhappily, too, for the credit of many parties concerned, the men whom we have most to thank for this wonder worker, which is so manifestly blessing the whole race of mankind, were allowed to share the fate of many other great inventors. The Messrs. Fourdrinier, and their ingenious engineer, Donkin, deserved well at the hands of their country, but more especially so at the hands of the paper manufacturers, who were reaping the immediate advantage of their labors. Sad it is to think that the fruit of all their labors to them was a loss of £60,000, hopes scattered to the wind, and their whole lives embittered.

Before the introduction of the Fourdrinier machine, many minds had been at work, fully realizing the advantages to be derived from a speedier method of converting the pulp, now so easy of production, into paper. One of the most successful attempts at doing this by machinery was undoubtedly in the machine patented by Mr. Robert Cameron, of Springfield, near Edinburgh. But although this machine worked fairly well, it was after all only a machine for making hand-made paper, that is, the paper was made in sheets, and not in a continuous web. Indeed, this fact earned for the machine the nickname of the "Wooden Man." The following is a description of it, abridged from a paper by Mr. George Bertram, and it will explain what is meant by saying it was only a machine for making hand-made paper:

"The machine contained ten moulds in all, each being mounted on a square-shaped frame or carriage, having four small wheels, for the purpose of moving round the machine, which was of an elliptical form, or, as we might more appropriately term it, a model of an endless oval railway. The motion given to the mould frames was by means of a pitch chain, made to revolve on a chain wheel placed at each end, and in the focus of the elliptic. This chain was next to the inside circle of the so-called railway, having each of the mould frames attached at proper intervals so as to carry them forward and round the ends of the elliptic. When the moulds were passing along one of the sides of the machine the pulp, in a properly prepared state, flowed from a receiver upon each in succession. As each mould moved forward with its load, it received a side shake, and was rapidly swept round the end of the elliptic. On its journey along the other side, the frame was turned completely over, the pulp coming into contact with an endless web of felt moving at the same speed and in the same direction. The pulp and felt were heavily pressed together to remove as much of the moisture as possible, and the paper, as we may now call it, was taken from off the mould and retained upon the woolen cloth or web. This process is familiarly known in the trade by the term 'couching.' The moulds, in their journey round the end of the elliptic, were restored to their former position, ready to receive a supply of pulp. The web of felt upon which the sheets were deposited carried them forward to a pair of press rolls at a point beyond the machine, where they were picked off by hand and piled above each other—this latter part of the operation being in hand-made paper mills termed the 'laying.'"

This machine no doubt did very good work, and several of them were made and sent over to France and Dublin, where they gave very satisfactory results, as compared with the hand-made process then in operation. They had, however, many manifest defects, which were never overcome, and which ultimately led to the construction of an entirely different machine; but it was found to be no improvement, and ere long gave place to the Fourdrinier machine, which was now being brought extensively into use.

Before entering upon a description of the process of manufacturing paper, as at present conducted in this country, let us look for a moment into what may be called a paper-mill of the past, although it is still busy at work.

In a secluded little hollow on the banks of a rather picturesque stream in the Midlands of Scotland stands the quaint little mill to which we refer. Though chemicals had not been unknown in this primitive little place at the time of our visit, none whatever were in use. The flax was being boiled by direct fire heat in an open caldron, none of the steam boilers now so generally in use having been introduced here. After being boiled, the flax was transferred from the caldron to the breaking or beating engine, of which there were two of the most primitive construction. The whole operation was conducted in one engine, the process of disintegration not being carried very far. From the engine the stuff was run into vats, where it was diluted with water, and kept in suspension by an oar occasionally stirred. The house in which the vats and presses stand is somewhat interesting. Two vats occupy one end of the chamber, a hand-screw press stands in the center and another, not in use, at the opposite end. One man is at work making paper on the usual moulds. These he passes in turn to the coucher, who transfers the paper to a heap, on which a layer of felt has been last laid. The heap, or "post," after having attained a few inches in thickness, is passed to the press, which is worked by means of a long pole put through an eye in the screw, and shifted every quarter turn. Four men put the requisite pressure on the pole, and two boys attend to the replacing of the heaps in the press.

The paper, after having been pressed, is hung up to dry in lofts, where the winds of heaven have free play, and by-and-by effect the desired end. It is then pressed again in the finishing house, where the torn or faulty sheets are removed and the perfect ones made up into reams for the consumer. The production was about two cwts. per day. These operations go on from week to week, and, altogether, a more antiquated process it would be difficult to conceive.

In contrast to this, and in order that we may see something of modern machinery, we shall now, with the courteously granted permission of the Messrs. Cowan, visit the Valley-field Mills. They are situated on the banks of the Midlothian North Esk, a stream which will be long memorable because of the prolonged litigation between the riparian proprietors and the paper makers, in reference to the pollution resulting from the nine paper mills which stud its banks from Lasswade to Penicuik.

The Messrs. Cowan have on this stream no fewer than four mills. For our present purpose, we will treat them as one. Indeed, three of them are so close together that, although they have locally different names, they are widely known as the Valley-field Mills. Originally erected by the Queen's printer in 1709, they passed into the hands of the Cowan family about 1780, and since then, by the skill and enterprise of the leading members of the firm, the works have developed to a marvelous extent—from a production of a few cwts. per week to about 100 tons. The Messrs. Cowan have had a share in the invention and introduction of improvements in the processes and appliances involved in the production of paper. To some of these we may have occasion to allude in subsequent lectures, our purpose in this introductory lecture being more general, and intended to open up the field for closer after-study. Six Fourdrinier machines are now fully occupied, and the gross annual production, chiefly of the finer sorts, such as writings, drawings, plate, etc., is not much less than 5,000 tons. Sixteen large boilers keep twenty steam engines, with an aggregate of 1,012 horse power, at work, and supply the steam for boiling the rags and heating the drying cylinders. Besides this, four water wheels are leagued with the engines in keeping the numberless wheels and drums in motion.

The rag and esparto stores are chiefly on the seaboard, and as they are interesting only because of their great extent, we shall not linger over them, but at once proceed to the cutting and sorting room. It will be convenient to confine our observations, as much as possible, to one class of raw material in describing the various operations; therefore we shall make our paper of rags, referring in passing to the modifications required in the treatment of esparto and other fiber-yielding materials of a similar nature. The room which we first visit is provided with long ranges of tables, along which, at convenient intervals, females busy at work are stationed. They are each provided with a scythe-like knife, fixed to the table in a slanting direction, so that the face looks upward, and from the worker, whose duty it is to rip up the seams, cut off buttons, hooks, buckles, pieces of rubber, etc., and cut the rags into pieces, three or four inches square. The rags, after undergoing this operation, are placed, according to their quality or color, into various receptacles provided for them. Previous to reaching the paper mill the rags have been sorted or classified, but never to the extent required by the careful paper maker.

The cut and sorted rags are next taken to the willowing and dusting machines, which occupy an adjoining apartment. In the "willow" the rags are dashed about and the dust knocked out of them by a series of arms or spikes, which revolve with great rapidity inside the casing. From the "willow" the rags pass to the "duster," which is simply a perforated revolving cylinder set at an angle, in which they are tossed about, the dust passing through the perforations, and the rags discharging at the lower end, which is open.

In the case of esparto, roots and other impurities are carefully picked out. This operation is also performed by females, the grass being shaken out and passed over perforated tables in front of them. Whatever be the nature of the raw materials, they are now ready for the boiling house, which is a capacious chamber, with ranges of large boilers of the prevailing type on either side. Here there are also two very large diagonal revolving boilers. The charge for each boiler ranges from ten to forty cwts., and in addition to the fibrous materials caustic soda, at the rate of so many lbs. per cwt., depending upon the nature and quality of the materials to be treated, is introduced with a due proportion of water. Having been duly charged, the boilers are closed steam tight, and steam turned on. From six to twelve hours are required to complete the operation of boiling. When the operation is completed, the spent soda liquor is drained from the boilers and evaporated, and the soda recovered and causticized in an adjoining building, the product being used again with a fresh quantity of rags or grass. The recovery process is not always one of choice on the part of the paper maker, but often of necessity for the purpose of obviating the pollution of streams. After what are called the "boilings" are run off, the boilers are filled with cold water, for the double purpose of cooling the material and removing a portion of the residual spent soda liquor. This second water, when run off, is called "coolings."

The rags are now removed from the boilers and again picked, the dusting and boiling processes having brought to light objectionable matters which had formerly escaped detection.

The breaking, poaching and beating processes which follow this second picking are all conducted in machines or engines of the same general construction. For our present purpose the description we have already given of the "Hollander" or "beater" will suffice. The engines are placed at different levels, the breakers being highest, so that their contents may be run into the poachers at a lower level. There are frequently two sets of beaters, the first and highest set being called "intermediates," and these discharge into the lower set, where the process of comminution is completed. In the breaking-engines the process of washing is conducted, and the tearing out of the fiber begun. The product of the washing or beating-engine is called "half-stuff." This so-called half-stuff is bleached, or at all events mixed with the bleaching liquor, and partially bleached in the poacher. When the bleaching is not completed in the poacher, the half-stuff with the bleaching liquor is run down into stone chests, where the process is allowed quietly to proceed until the desired color is obtained. The bleached half-stuff is drained and pressed, to remove the residual liquid, and is then put into the intermediate beater, where the remaining traces of chlorine are removed by washing, or destroyed by chemical agents, and the process of comminution carried to a considerable degree of fineness. The china clay, pearl hardening, or other loading materials, are generally put into the intermediate when this engine is used. In the beating-engine proper, into which the stuff is finally run, the process of disintegration is completed, and the coloring matter and alum size added.

The operations which we have thus briefly described are conducted in four separate apartments. The engine-house is a lofty, well-lighted, spacious room. The bleaching-house is lit from the roof, a large proportion of which is of glass, the natural bleaching action of sunlight being thus so far taken advantage of. The press-house contains a set of powerful hydraulic presses, capable of doing a very large amount of work. The bleaching liquor is prepared in a series of stone vessels fitted with agitators driven by gearing, and the liquor which drains from the residual lime is stored in large stone or slate cisterns.

Before the pulp or finished "stuff" is run from the beaters to the vats which supply the making machine, it should be in a very fine state of division and of perfectly uniform consistency. When diffused through a large quantity of water it should scarcely be distinguishable as fiber, but should have more of the appearance of a solution somewhat like churned milk.

Having prepared our stuff, we must follow it to the machine-house, where we shall see it with wonderful rapidity and nicety converted by the Fourdrinier machine into a web of perfect paper. The Messrs. Cowans' six machines are of various widths, and are placed in several houses. The reason of this is obvious in mills where for many years the growth has been gradual; it is difficult to secure such a general arrangement of parts as one could desire, and which is indeed only attainable in erecting an entirely new establishment. It was in this mill that the Fourdrinier machine was first erected in Scotland. In order that we may have the opportunity of witnessing, under the most favorable circumstances, the conversion of pulp into paper—a very interesting operation—we shall choose one of the machines recently constructed by Messrs. George and William Bertram—a machine which makes paper up to a width of seventy-five inches, and is constantly employed on the finest classes of writings.

When the pulp is discharged from the "beaters," it is received into large vats, or chests, fitted with mechanical agitators to keep the pulp from subsiding and the mixture uniform. From the chests it is measured out, in steady, uniform quantities, into a mixing-box, where it is extensively diluted with water, or with the drainage from the machine wire, and then allowed to flow through the "sand trap." This may be described as a long, shallow tray, folded upon itself to economize space. The sand and other gritty matters which the previous processes have failed to remove are retained in this "trap," or tray; hence it takes this name. From the "trap" the pulp flows into the strainers. These are of two kinds; but, for our present purpose, they may be described as a series of sieves, consisting of brass plates, perforated with very fine slits, through which the properly comminuted fibers pass, but which retain all knots and impurities of a similar character. This is the great purpose of the strainer, and it plays an important part in the production of a high-class paper. Without the strainer all sorts of specks and blotches would disfigure the finished sheet, for even the smallest speck of impurity is magnified into an offensive spot when it passes between the calendering rolls. From the strainer the pulp flows over an apron on to an endless sheet of wire cloth, which is continually carrying it forward. This endless sheet or band is carefully stretched upon and borne up by a series of rollers, so as to form a perfectly flat surface on the upper side. The water, of course, passes through the meshes of the web, leaving the pulp more and more like paper at every inch of its journey. The wire has a slight lateral motion or shake communicated to it, which causes the fibers to sort themselves, and interlace in such a way that a closely compacted and strong sheet of paper is the result. Without the shake the paper would not be so homogeneous, and would tear more readily in one direction than another. The draining or dyeing of the pulp on the wire is promoted by very ingeniously applied suction-boxes, which are of equal width with the web, and are kept in a state of partial vacuum by the action of air pumps. The changing condition of the fabric, now taking shape, is rendered very manifest as it passes over those particular points; the pulp, visibly wet at first, is soon only moist, and before it reaches the end of its journey on the wire the result is so striking that no one would hesitate to call it paper. There are many wonderful and ingenious processes in the manufacture of paper, but none of them are so striking, interesting, and rapid of accomplishment as that by which the pulp, milk-like at the beginning of the wire, is in six seconds of time converted into beautiful, though moist, paper. I have frequently had the pleasure of showing and describing to intelligent friends the manufacture of paper, and I have always noticed that this part of the process was the most attractive and interesting.

The width of the paper is regulated by what are called "deckle" straps or bands, which move with the wire, and can be adjusted to any width which the machine is capable of making.

It is while the paper is still on the wire, and generally immediately after passing the first suction-box, that the impression is given to it, by what is called the "dandy roll," which creates the distinction of "wove" and "laid" as applied specially to writing papers. From the same roll names and trademarks, which are known as water-marks, are impressed upon the fabric. There is virtually a thinning of the paper where the marks on the "dandy roll" touch the sheet, so that what is thus imprinted can never be effaced from the paper.

The moist paper as it reaches the end of its journey on the wire passes underneath, and is pressed by what is called the "couch roll." Immediately on passing this, the paper leaves the wire and is received on an endless web of felt, by which it is carried through the first press rolls, where a quantity of water is removed and the fibers more closely compacted. By an ingenious arrangement the felt and paper are carried forward to the next press rolls in such a way that the surface of the paper previously in contact with the felt is now in contact with the metal roller, and *vice versa*. This arrangement was devised with the view of equalizing the surface as much as possible, and although a decided improvement is effected by it, the impression made by the felt in passing the first press roll is never completely effaced. The press rolls are kept clean by means of scrapers or "doctors."

The paper, now sufficiently dry and compact to carry its own weight, leaves the felt and passes over to the drying cylinders, which are made of cast iron, turned smooth, and heated by steam. The paper is carried round each cylinder in succession, and is kept in close contact with them by means of endless felts, working over a series of rollers placed round each cylinder. Having been thoroughly dried in this way, the paper, in ordinary cases, would have, with or without passing through a set of calendering rolls, been wound into reels and removed from the machine, to be cut up and finished elsewhere; but, in the case of the machine before us, the paper has not yet made half its journey. As the paper leaves the drying cylinders it is warm, and, therefore, not in a good condition to be surface-sized; it is consequently passed over a roller, kept cool by a current of cold water circulating through it. Having been cooled, the web is immersed in the size, or gelatine, which is contained in a trough, or tub, in which a roller works, and by its means the paper is taken down into and carried through the size. It is thus thoroughly impregnated with gelatine, the surplus of which is removed by another pair of rollers, between which the web, again wet, passes.

A new and entirely different drying process now begins. Steam drying would destroy the size, and render the paper brittle; a much slower process is therefore adopted, in which air currents act as the drying agent. The drying apparatus before us consists of no fewer than 200 skeleton cylinders, ranged in three tiers; inside each cylinder, but, revolving

independently of it, is a fan for producing currents of air. The fans, which move slowly in the earlier cylinders, increase in speed as the paper moving forward gets dryer, and better able to bear the action of stronger currents. The web is guided along through this labyrinth of cylinders by means of tapes or bands, and by the time it reaches the end of its journey is perfectly dry, and able to bear and benefit by the pressure of the calendering rolls through which it passes previous to being cut up into sheets. This cutting up is the final operation to which it is subjected in this wonderful chain of processes. In the short space of seventy minutes, and without a break in the continuity of the process, the paper is made, sized, dried, calendered, and cut into sheets—pulp at one end of the machine, sheets of fine writing-paper at the other. It may be mentioned that the length of paper on the machine at one time is about a mile.

The machine we have described is one of the very few in this country on which the various processes are so continuous. The rest of the machines in this mill finish their work, as most others do, by winding the paper, engine-sized or unsized, as soon as dried, into reels. These reels in the case of printing papers are at once transferred to the cutting machines, where they are first ripped up into widths and immediately thereafter cut into lengths. In the case of engine-sized writings the reeled paper is simply ripped up into two or three widths and reeled again, then passed through the web calendering machine, and finally cut into sheets. Paper intended for surface-sized writings or such like is transferred to the sizing tub, and air-dried in the same manner as we have already described in the case of the continuous machine, then cut into sheets and taken to the finishing house, which is an extensive establishment, lofty and well lighted. Here we find many nimble fingers at work making up the sheets into piles about an inch thick, each sheet being separated from that above and below by plates of copper of corresponding size. The piles are passed backward and forward several times between the rollers of what are known as board calenders, which gives the paper a fine, smooth surface. If a very high glaze is required, the sheets of paper and copper are interchanged and again passed through the rollers, and this may be repeated several times. Of course each sheet is carefully examined, and all marked or faulty ones removed and piled into a heap by themselves.

There are many other interesting, although secondary, processes in operation in such extensive establishments as the one we are now describing, but these we can only briefly refer to at present. There is, for example, the house for preparing the bleaching liquor, in which are placed a range of large stone cisterns fitted with mechanical agitators; the size house, where the "scrows," or raw material of animal size, are steeped and cleaned, and finally dissolved in copper vessels fitted with steam jackets; the apartment where the china clay and starch are prepared for the beating engines; the sheet-sizing room, and air-drying lofts, where the old method of treating hand-made papers is applied to machine-made writings in a modernized fashion. There is also the stamping house, where the finished paper is bundled up and weighed, and the extensive stores for the various classes of finished goods. Then we have the usual ranges of mechanics' shops; the engineering establishment, with its planing, turning, and boring machinery; the carpenters' shops, with all sorts of appliances constantly under construction; the smithy, with its blazing fires and sounding anvils; the plumbers' quarters, where lead is made to assume many a fantastic shape, to suit the exigencies and intricacies which it is intended to meet.

Besides all these we have the extensive water system; water for driving purposes, collected and deviated by a weir thrown across the Esk, and led into the mill by a race or lade to the various water-wheels and turbines; water for washing and for diluting the pulp for the machines, collected from various pellucid springs and stored in extensive reservoirs. The purity and abundance of the water supply of a paper mill is of the utmost consequence, and in many cases the character of the available water determines the character of the paper to be made. The water, after having served its purpose in the mill, has to be got rid of in some way, and as it has acquired much impurity in the various processes, it is not allowed to flow direct into the stream, but must first be purified as far as practicable. We have, consequently, a large area occupied with settling and precipitating ponds, filters, drainers and evaporators.

Lastly, we have the iron way, with its locomotives, "Valley-field" and "Inveresk," carrying the raw materials into every corner of the mill, and removing the beautiful finished product to be distributed all over the world, to what diverse purposes to be applied I leave each one to picture for himself. The history of the application of the product of one day's work of such a mill would certainly afford pictures of both the gravest and the gayest types, and would be more deeply interesting than the finest strung romance; the various themes upon which ten thousand heads and hearts would discourse on the sheets; the many errands on which they would be sent, and the many emotions which they would kindle in every clime we can only faintly imagine.

I conclude this lecture with some statistics of the trade, which will serve to give an idea of its magnitude and of the universal application of the product.

The number of mills at present working in England is about 300, in Scotland 65, and in Ireland 20, in all about 385, being an increase of 40 or thereabout in the last decade. The total number of machines at work in the three countries is about 526, producing an annual aggregate of 350,000 tons, to which must be added say 10,000 tons made by hand, making our total production 360,000 tons, the value of which may be taken at £16,000,000 sterling. Our exports are about 16,000 tons, but we import 24,000 tons, showing that we consume 6,000 tons more than we produce.

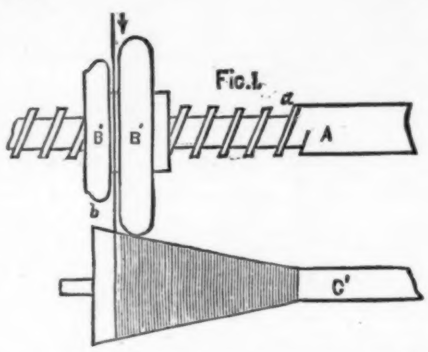
Of the raw fibrous materials used in the production of paper we import between 17,000 and 18,000 tons of rags and 190,000 to 200,000 tons of esparto and other vegetable fibers. The gross value of these imports is about £1,700,000.

Dr. Rudal, of Vienna, gives some interesting statistics, and although they appear to be rather out of date, in the absence of more recent accurate information, we may note a few of his figures. He gives the total amount of paper made on the globe at 1,800 million German pounds per annum, one-half of which is used for printing, one-sixth for writing, and one-third for other purposes. The aggregate number of persons, male and female, employed in the manufacture he gives at 270,000, with an additional 100,000 employed in gathering rags.

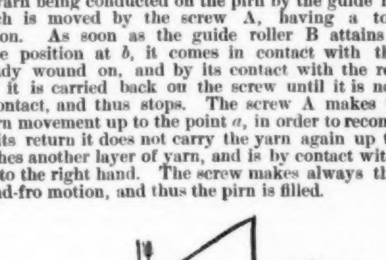
Dr. Rudal also informs us that a Russian consumes annually 1 lb. of paper, a Spaniard 1½ lbs., Mexican of Central America 2 lbs., Italian and Austrian 5 lbs., Frenchman 7 lbs., German 8 lbs., United States 10½ lbs., and Englishman 11½ lbs.

## IMPROVEMENT IN PIRN-WINDING.

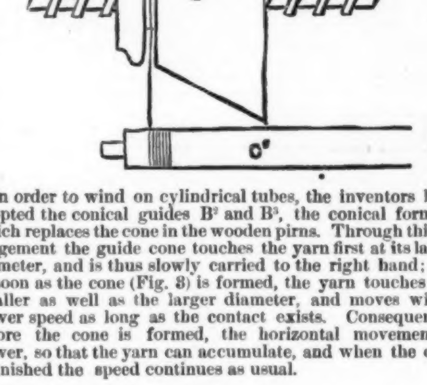
THERE are two ways of winding the yarn on the pirns, says a French contemporary, the older one with a horizontal spindle, mostly used in Switzerland and Saxony, and the newer one with the vertical spindle, in vogue in England and Germany. The improvement to which we direct the attention of our readers is the invention of Messrs. Abbegg and Adoff, and refers to the horizontal spindle upon which until now only wooden pirns could be placed, and, as the latter are conical, they can only contain a small quantity of yarn; straight tubes instead of these pirns could, so far, not be used.




The present way of filling the pirns is shown in Fig. 1, the yarn being conducted on the pirn by the guide roller B, which is moved by the screw A, having a to-and-fro motion. As soon as the guide roller B attains its extreme position at $b$, it comes in contact with the yarn already wound on, and by its contact with the revolving pirn it is carried back on the screw until it is no longer in contact, and thus stops. The screw A makes then its return movement up to the point $a$, in order to recommence. On its return it does not carry the yarn again up to $b$, but touches another layer of yarn, and is by contact with it carried to the right hand. The screw makes always the same to-and-fro motion, and thus the pirn is filled.




In order to wind on cylindrical tubes, the inventors have adopted the conical guides B² and B³, the conical form of which replaces the cone in the wooden pirns. Through this arrangement the guide cone touches the yarn first at its larger diameter, and is thus slowly carried to the right hand; but as soon as the cone (Fig. 3) is formed, the yarn touches the smaller as well as the larger diameter, and moves with a slower speed as long as the contact exists. Consequently, before the cone is formed, the horizontal movement is slower, so that the yarn can accumulate, and when the cone is finished the speed continues as usual.




The advantage of this invention consists in the possibility of putting as much yarn again on the tube as usual, and the pirns formed in this way last much longer in the loom.

We have reproduced the above because the moving cone seems to us to be a different arrangement from that used in this district, and may have some advantages, but our contemporary seems to be ignorant of the fact that good and firm pirns are now made in England upon the bare spindle, nor does he seem to be acquainted with the Scotch arrangement of horizontal spindles.—*Textile Manufacturer.*

---

THE report of the captain of the French man-of-war on the Iceland station, giving the results of the fishing of 1877 in the vicinity of that island, has been published. Altogether, 237 French boats, manned by 4,205 men, were employed last year. The fishing fleet left France in the latter part of February and beginning of March, and reached the shores of Iceland during the course of the last-named month. It was nearly the end of April before fishing could be begun in earnest. After the weather moderated, however, the season proved to be an unusually good one. The cod arrived in such large shoals that the number taken by each boat depended solely upon the strength and energy of the crew. Forty-two boats were visited by the captain of the French man-of-war, and the total number of cod taken by these amounted to 1,129,328, being at the rate of 1,220 fish for every man of the crews.

## A BOBBIN, AND HOW IT IS MADE.

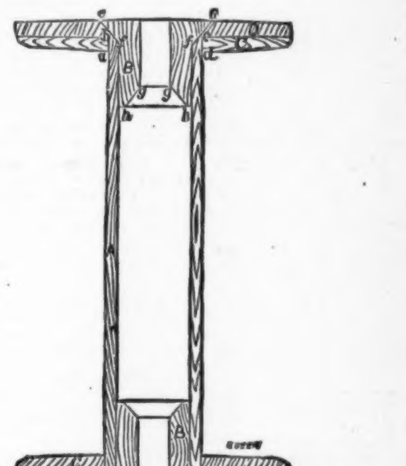
It has now become almost too stale to insist on our exceeding ignorance of the antecedents of common things. "Things not generally known," it would seem, are those we ought to know the most about; and although it is paradoxical to assert it, it is almost a truism that, generally speaking, the more we handle an object, the less is our knowledge of its history. Not to quote the too backneyed instance of the manufacture of a common pin, take that even more indispensable article—a pen. How many of us who use one every day of our lives know how it is fabricated? Looking at that little instrument, which, by common consent, is mightier than the sword, we see simply a small piece of steel, fashioned by being bent, punched, and split in a certain manner, and yet to produce it nearly every force and every process in nature have at one period or another been brought into operation on the material of which it is composed. Before the iron and the carbon in the steel had been extracted from the earth, and subjected to treatment by man, the molecules of those elements had a history of their own, more romantic than any novel; but that history is unfortunately a sealed one to many, on account of the unfortunate and lamentable want of scientific culture even in circles called educated. The manufacture of a pen, the artificial treatment by which it is converted into the finished article, involve methods of manipulation of more absorbing interest for the generality of readers, but the scope of our journal does not permit our noticing them in detail.

In the textile trades there are some articles used, and used in thousands, the very commonness of which, apparently, would almost stamp them as uninteresting, and forbid them receiving mention at our hands. We, however, think that very useful, instructive and entertaining matter may be extracted by a careful study of the way in which these "vulgar things" are transformed from the raw material to the finished articles. It shall be our purpose from time to time to select some simple article, kicked about it may be on the floor of a mill or mechanic's shop, and write its history. We commence with the article known as a "warper's bobbin."

It is equally true of this bobbin, as it is of a pin or a pen, that to make it

> Not one or two processes suffice for the feat,
> It requires a great many the change to complete,
> And when the the thing's done it looks very neat,
> Which nobody can deny.

A single glance at it would tell us that it consists apparently of three pieces—the two "heads" or ends, and the "barrel." But sawing one up the middle, and carefully inspecting the section (see Fig.), would show that there are seven distinct parts, viz., the barrel A, the bushes B, and the two pieces C and D, which compose each of the heads. It is a common practice with bobbin manufacturers to make the barrel of ash, bushes of beech, the inside pieces (C) of the heads of fir, and the outside pieces (D) of alder.



Commencing with the timber in its rawest form, so to speak, we have but the partially seasoned logs. The most economical and convenient way of working it is to cut the timber into blocks, not into planks, for the former plan admits of it being more readily sawn into the required forms. The first operation, therefore, is "cross-cutting," which consists in sawing the logs crosswise into short lengths. The log or baulk is placed on a carriage in front of a circular saw, which, being mounted on a saddle, is capable of automatically advancing toward the log. Lengths are thus easily sawn off with the minimum of handling of the log itself. The next step is to transfer the lengths so cut to the table of another circular saw, where they are "planked" and "squared." The timbers for the barrels have now been shaped, so as to be about 1½ inch square in section, and about 7 inches long, or just sufficient for a bobbin. The next treatment is to bore these blocks longitudinally, and this is done in a very ingenious boring machine. In the former, the pieces of timber are fed one by one into notches, on what may be called a revolving barrel, with an automatic intermittent motion, which places them endways between the points of two augers. The cutting portions of these augers, lubricated by the machine itself, advance toward each other, and bore the timber from each end, withdrawing themselves now and then to clear the shavings from the hole. The barrel, after being bored, is dropped by the machine into a receptacle underneath, and another takes its place, to be operated upon in like manner. The blocks are next taken to a lathe, and after being roughly shaped into the cylindrical form are stacked aside to dry and season, which, of course, is greatly facilitated by the manipulation the barrels have undergone. The timber blocks for the heads are about 4 inches square in section, but of no particular lengths, the grain of the timber in this case not running lengthways but across the blocks. These pieces, after being bored longitudinally up the centers, are cut into thin plates by having slices sawn off their ends. These slices are intended to form the heads of the bobbins, and as they leave the saw are about 4 inches square, and rather more than a quarter inch thick, with holes in their centers. They are put aside to dry, the seasoning being expedited by the reduced dimensions of the timber. The beech intended for the bushes is subjected to the same general

treatment, but the blocks operated upon are, of course, smaller. The succeeding process is to piece or pair together the plates C and D, of which the heads are composed. One of the before-mentioned slices of fir, thoroughly seasoned, is placed on another slice or plate of alder with a layer of hot glue between, and so that the grains of the pieces cross, and the pair is subjected with several other pairs to a pressure of about four tons in a hydraulic press, until the glue is set. It is obvious that the object of making the head or flange in two pieces, and crossing the grain in the manner described, is to get uniform strength all round, which would not be the case supposing the head was made in a single piece. When the glue is dry the pair is practically a single piece, and as such it is treated; the hole in its center is therefore "shelled," or cleaned out to the required size, and the piece is "grooved," that is, the recess *a, b, c, d*, in which the end of the barrel is inserted, is cut out by the piece being held against a suitably shaped bit, fixed in a revolving mandril. The barrels, after seasoning, have likewise their holes "shelled" out, and the ends "tenoned," that is, cut down, so that they nicely fit the recesses *a, b, c, d*. The building up of the bobbin may now be commenced, and to this end the two heads are placed on the barrel, preceded by the application of a little glue, and forced home by means of a screw press. The glue having been allowed to dry, the counter-sinking of the portion *e, f*, is proceeded with in the same machine as did the "grooving," but with a differently shaped tool, as a matter of course. Some glue having again been applied to secure the parts, the bushes B are forced in by screw pressure, and, as far as the parts are concerned, the bobbin is completely constructed. Inside the bobbin it will be noticed that the bushes are countersunk at *g, h*, with the object, as many of our readers will know, of diminishing the risk of knocking out the bush by the spindle end when the bobbin is placed over the latter. The heads are still square and the whole thing is altogether in a very rough condition. The corners, therefore, are removed, by a cutter fixed in a revolving face plate, to nearly the finished dimensions, and the holes in the bushes are "shelled" out, so that they are both truly in line. The bobbins now pass to the hands of the turners, whose duty it is to clean and trim them up to the finished size, which they do upon a mandril, using for the purpose specially shaped tools, set so that every bobbin is turned out of exactly one size, and without any gauging or measuring on their part. The almost beautiful finish of the work, the rate at which it is done, and the dexterity and skill of the operatives, are very surprising to one unaccustomed to watch the turning and finishing processes. The bobbins have now to be painted and varnished. They are placed by a lad, one by one, on a mandril on a lathe, and, when revolving, the paint, usually vermillion color, is applied with the bare hand. After drying, they are again placed on the mandril, and the roughness of the paint being removed by a rub or so from a sheet of sand-paper, varnish is applied, and the bobbins are finished ready for the market. Such of our readers as have followed this description will see there is some art in making even a bobbin; in fact, in its fabrication it is handled, either in the whole or in parts, no less than seventy-eight times.

We are indebted to the courtesy of Messrs. Henry Livesey, Limited, of Blackburn, for kindly allowing us every facility for studying each operation, not the least of which was a very intelligent foreman as a guide. We may remark, *en passant*, that in walking through Messrs. Liveseys' establishment we were much struck at the number of businesses carried on by the firm, and we were told that the various tools in use, including the engines, etc., were made by themselves. Beside manufacturing bobbins, shuttles, and other small requisites for mill use, we find they are cotton manufacturers and machinists as well, and in the latter capacity are more especially engaged as loom and colored winding machine makers. We noticed several important points in the details of their looms which deserve praise, the workmanship of which appeared quite up to the mark. The fact that they are fully occupied with orders, even in these bad times, speaks well for their reputation in this respect.—*Textile Manufacturer.*

## LECTURES ON PARALYSIS AND CONVULSIONS AS EFFECTS OF ORGANIC DISEASE OF THE BRAIN.

*Recently Delivered at Bellevue Hospital Medical College, New York.*

By C. E. Brown-Sequard, M. D., etc.

### Lecture V.

Gentlemen: You may remember that a fortnight ago I examined the question relative to the diagnosis between cases of disease of the various portions of the base of the brain and cases of disease of other parts. I said that paralysis caused by disease of some portions of the brain is sometimes very difficult to diagnosticate from that caused by disease of other parts, but I gave you some points that will enable us in many cases to come to an accurate conclusion. Among the symptoms that I did not mention there are a few that will now receive our attention.

When the paralysis is located on one side of the body from disease of the pons Varolii, if the face is paralyzed—and it almost always is from a lesion in this location—the paralysis will be on the opposite side in most cases. It may be on the same side, and the difference exists according to the seat of the lesion.

If it be low down near the medulla, the roots of the facial nerve will be affected, and we shall have alternate paralysis. If the lesion be in the upper part of the pons Varolii, the symptoms are different, the paralysis of the face will be on the same side. In most cases, however, the paralysis of the face and limbs are on opposite sides of the body. In disease of this portion of the base there is one important feature which must not be overlooked. If you look at a patient suffering from paralysis from brain disease in this locality, you will notice something that is absent from most other cases. This is a lack of power in closing the eye. The orbicularis muscle of the eye is paralyzed only in cases of disease of the pons Varolii. You usually do not find this particular symptom in other cases. If you tell the patient to close his eye he can not do so. In this feature there is a characteristic difference from other cases, showing that the disease is in the pons Varolii, or is not there. When this symptom is present there is really almost a certainty of the existence of disease in the lower part of the pons Varolii. This is an important point, as you will see in my last lecture of the course, for the means of treatment are not the same when there is a difference in location of the lesion.

There are still other symptoms that show when the disease is situated in the pons Varolii or medulla oblongata. Among the number is a symptom called nystagmus. This consists in a trembling to and fro of the eyeball. It seems to the patient that the objects in his vision are trembling and moving to and fro, for the trembling of the eyeball gives him that delusion.

Still another feature of interest consists of a symptom that has only been studied during the last twenty years. Vulpian of Paris and Prevost of Geneva first called attention to it. It consists of a turning of the neck to one side, and a conjugated deviation of the eyes to the same side. If you look at my head drawn over to the left shoulder, and my eyes looking in the same direction, you see an instance of conjugated deviation of the neck and eyes. This is a frequent symptom in cases of softening of the brain and likewise in cases of hemorrhage in that organ. As regards this symptom, there is something peculiar in this respect, viz.: in cases of disease elsewhere than in the pons Varolii the tendency of the head and eyes shows itself toward that side in which the injury exists.

This symptom comes on, the same as convulsions, wherever the disease is in the brain. The head turns to the side of the disease. If the lesion be on the left side of the brain, the head and eyes turn to the left, and, on the other hand, if the lesion be located on the right side, the head and eyes turn to the right. In most cases you will find the head turned away from the paralyzed side toward the sound side.

Now, when the disease is in the pons Varolii we very frequently have the reverse of this condition, the head and eyes being turned toward the paralyzed side of the body, and not toward the injured side of the brain. Here, then, is a diagnostic point between disease of the pons Varolii and other parts of the brain. Still there are cases in which the deviation occurs in the wrong way. Instead of being to the side toward the injury, or *vice versa*, it may be to the opposite, but in most cases the rule I have mentioned holds true.

Before passing to other parts of the nervous system, I must tell you that there are two things which I should like you to remember, that show conclusively that our doctrines as regards the physiology and pathology of the brain and cord are so wrong that they deserve no credence. These two facts are: 1st. There are many cases on record in which, without any marked paralysis having been observed, the pons Varolii and medulla have been in a great measure altered. Indeed, a very few fibers of communication between the upper part of the brain and the spinal cord are sufficient for the persistence of all voluntary movements. If this fact be true, that only a few fibers in comparison to the immense numbers that exist are sufficient for the communication between the brain and spinal cord, you can easily understand how it is that in some cases large portions of these parts of the brain may be destroyed without symptoms, as in the case related by Stanley of St. Bartholomew's Hospital.

This case was that of a sailor who died without any symptoms of paralysis, yet at the autopsy the medulla was found so reduced in dimensions that it did not measure one fifth of its ordinary size. An exostosis was found blocking up the channel between the cranium and the spinal canal. The aperture of the foramen magnum was reduced so much in size that it was impossible to pass the little finger through the opening. Still the man acted as a sailor, and did all of his ordinary duties as such, with his ordinary undiminished power, and he died of another affection without at any time having any kind of paralysis.

There are many other cases of the same kind of equal force. The odontoid process has been enlarged and caused pressure on the medulla, rendering it extremely small. In such a state it could not be healthy. The medulla in this state, when cut, gives a hard, cheesy appearance. In a case by Beamis, in which no paralysis was observed, a microscopical examination of the medulla showed that not a single fiber remained healthy. Most of it was transformed in a tumor, and what remained showed a considerable alteration. There are, then, a great many cases of partial or total destruction without any marked paralysis. I say *marked* paralysis, for these writers say there was none whatever, but I allow for the inadequacy of our means of determining paralysis.

Such facts may seem very strange to you, especially when you know that the pons and medulla are most delicate parts, and in which a sudden injury proves instantaneously fatal in many cases. A mere prick in the medulla will kill an ox. You well know that in Spain, after the bull-fights, the means of killing the wounded or infuriated animals consists in passing a poniard through the muscles of the neck into the medulla. In small animals this is very easily done, and a mere prick in the medulla causes death invariably. Although death is caused so easily by injuries in this location, lesions coming on gradually may cause alterations in the structure without symptoms. In many cases of hemorrhage into the pons Varolii no signs of paralysis may occur. Hughlings Jackson has seen one of the numerous contradictions between the facts as they are and as they should be in such cases. In sudden injuries and gradual diseases in these parts, not only has death not supervened, but even no symptoms of paralysis have been manifest.

The second point is also most important in this connection, and shows that the old views must be laid aside, as they are in opposition to thousands and thousands of facts. What I have said clearly shows that no decussation in the base of the brain is essential for the conduction of motor impulses. What is usually taught consists in admitting that paralysis appears on the opposite side of the body from the disease in the brain on account of the pretended decussation of the motor fibers, those from the right and the left crossing to the opposite side in the pons or medulla, or in both. The decussation, it is easy to show by facts in very large number, does not exist there.

I have already pointed out to you a number of these facts. There are a number of decussating fibers, it is true, but they can not be voluntary motor fibers. You can not admit, in the face of these facts, that the voluntary motor fibers decussate in the pons Varolii or medulla. If I show besides this, that there is no part of the brain in which the decussation exists, we must admit that there is no decussation.

Anatomy teaches that the bonds of union between the brain and spinal cord are the crura cerebri, pons Varolii, and medulla oblongata. The cerebellum has never been looked upon as the bond of communication, and it would be absurd to do so, because there have been a number of cases of disease of the cerebellum without producing any paralysis.

The only channel admitted by every one is the front part of the base of the brain. The question as regards paralysis is whether there is any decussation.

Suppose there is a disease in the pons Varolii destroying everything there—and there are a great many such cases—we should have paralysis on both sides of the body; but this does not always happen.

Suppose, again, that the pons is destroyed in one of its halves. In most of these cases—not in all, but in most of them—the paralysis occurs on the opposite side of the body, and it may be absolute. Now, what conclusion do we draw from this? It seems clear that the fibers serving for voluntary motion on the opposite side of the body all pass here, that is, on the side that is injured, as the paralysis is complete on the opposite side of the body. If you admit this fact, you must also admit the fact that the decussation does not include the voluntary motor fibers. If it did, you would have paralysis on both sides of the body, as in destroying one-half of the pons you would destroy the fibers belonging to the two sides of the body, those for the one side which have not yet decussated, and those that have already crossed over from the opposite side. If, therefore, the voluntary motor fibers decussate in the pons, a lesion on one side would produce paralysis in the two halves of the body, and not only on the opposite side, as it happens in most cases. The conclusion is positive, as we see in most cases that the paralysis occurs only on the opposite side, and in one clear case it occurred only on the same side.

We must likewise reject the view of Schiff and others, that decussation takes place in the medulla, and there only. The fibers that decussate lower down are very numerous indeed. If the fibers decussate in the medulla oblongata and are injured above their crossing, the facts would be easily explained. I believed that such was the case for a long time, and I published an article a long time ago, proving that the whole decussation was in the medulla, and facts were abundant which seemed to prove this opinion. If the disease is in one half of the brain, a degeneration takes place in the fibers going down on the same side, until it reaches the anterior pyramid, and there it seems to cross. I think it can be proven, however, that decussation does not take place.

If this is so, the decussation that is seen is not at all employed in conducting voluntary motor power. The voluntary motor fibers do not decussate in the brain at all. What are the facts?

There are many cases of disease in the spinal cord without any paralysis at all. The olivary bodies, the corpora restiformes, and the anterior pyramids can be destroyed without any paralysis at all on the opposite side. Experiments in animals show that in many cases division of the anterior pyramids produces no paralysis at all.

Section here can not prove anything but what is clear, that no effect is essential in section of one-half of the medulla oblongata. If decussation of motor fibers occurs, this could not be so.

If disease can destroy both halves of the anterior pyramids, as in the case of Vulpian, where a man walked into the hospital without any symptoms of disease of the brain and died soon after—the autopsy showed that almost the whole of the fibers of the anterior pyramids were destroyed or atrophied—it is clear that there can be no decussation of voluntary motor fibers in this location.

If we put these facts together, we find that the voluntary motor fibers do not decussate in the pons Varolii or medulla oblongata, and as there is no other part where we can discover a decussation of fibers, it is clear that the fibers which compose the decussation are not the voluntary motor fibers.

The other result that follows from this is that the paralysis which we find almost always to be on the opposite side of the body can not depend on the destruction of voluntary motor fibers.

This result we come to, not only from facts relating to paralysis, but also to convulsions. Convulsions, rigidity and stiffness of the muscles, chorea, tremulousness, and catalepsy can appear on the same side as the injury to the brain. So that we are not to look to convulsions as establishing decussation. If we look to cases of disease of the crura cerebri, pons Varolii, and medulla oblongata, we will find them with convulsions on the same side of the body. If the fibers of decussation were conductors of voluntary motor power, we should *always* have convulsions on the opposite side of the body. You could not have anything else; but as disease on one side of the brain has produced convulsions on the same side of the body, it is clear that the fibers of decussation are not what they are pretended to be, viz., voluntary motor fibers.

I have now to come to some other points; but I will take this subject up again in one of the last lectures, and try to show by what mechanism the will acts on the muscles, and also show some points of diagnosis when the facts seem to be in disharmony.

We come now to the diagnosis of disease in the cerebellum and crura cerebelli. I will say that any one that could give an hour or two to the study of cases at random would at once learn immensely in this respect. Almost any symptom can appear, and no one symptom is constant. The symptoms of disease of the cerebellum are varied, no matter what it is used for. I do not know what its office is, but if it serves for anything, it is an organ for the production of nerve force.

The most constant symptom produced by cerebellar disease is a general weakness. Even when the paralysis is only *local*, a *general* weakness exists. If there is nothing essentially belonging to disease of this portion of the brain, there are many symptoms that frequently appear with it, so that if a paralysis co-exist with these symptoms, it may lead you to expect that the disease is situated in that locality.

A loss of sight is a very frequent thing in these cases. Why, you will say, is this so? With the views I have given you, that any symptom may come on from disease in any part of the brain, it is easy to make such a symptom come under the rule. There is no connection, directly, that is to say, between the loss of sight and the cerebellar disease. It may be said that the lesion causes pressure on the tubercula quadrigemina from its close contiguity. A tumor will exert such pressure. If it be true that the centers of vision are located in these organs, the fact would be in harmony with such a theory. But what of those cases in which there is no pressure and the loss of sight exists, and still more, how is it in the cases I shall presently mention? Disease in the cerebellum alone may produce amaurosis of one or both eyes.

There is still another point. There are many cases of disease in the cerebellum of slight extent, and in which no pressure whatever was exerted on other parts of the brain. A condition of softening or inflammation in the cerebellum has caused amaurosis in the same way. This phenomenon is of the same nature as what occurs when teniæ or lumbricoides in the bowels cause amaurosis either in one or other, or in both eyes.

Some medical men have tried to explain this loss of sight in cerebellar disease by saying that it is due to effusion of serum into the ventricles, and caused by disease of the cerebellum. It is true that in some cases there is considerable

effusion of serum in the lateral ventricles. This comes from the fact that the sinuses of the brain are pressed upon by the disease in the cerebellum, and the circulation is thereby obstructed in one or both halves, according as the pressure is exerted on the veins. It is easy to admit such a cause in some cases, and the theory seems in harmony with the facts, but there are cases in which no serious effusion has been produced.

The truth of the matter is this, that a change in other parts of the brain can be caused by a disease in the cerebellum. The nutrition is altered, or there is the production of inhibition or the phenomena of the arrest of function, which I consider the great point.

What are now other symptoms which show that the paralysis depends on disease of the cerebellum? There are two other symptoms that are more or less constant,—headache in the back of the head, more violent perhaps than in any other case, and vomiting. The vomiting, I need not tell you, is caused by contraction of the muscles of the abdomen and diaphragm, and of the walls of the stomach. If you take the view that contraction of the muscles takes place from irritation of conductors or centers, how can you explain the vomiting? There are no fibers connecting the cerebellum with the stomach. No one has ever supposed the cerebellum to be the center for the stomach and for digestion. The vomiting is a reflected symptom. An irritation is transmitted to cells at a distance; other cells at a distance are put into play, and these act by putting into play the muscles of the abdomen, the diaphragm, etc., and thus the vomiting is produced.

Still another symptom to be noted is the great deal of disorder in the movements which is exhibited. The patient seems drunk when he attempts to locomote. If he walk at all, he progresses like a person intoxicated by alcohol. This symptom is not like what occurs in locomotor ataxia. You know that in what is called locomotor ataxia, where the disease is situated in the spinal cord, instead of planting the foot down firmly in the straight direction, the foot goes sideways and comes down, not on the flat, but on the heel. This symptom that we are speaking of as being present in disease of the cerebellum is not like that seen in locomotor ataxia, but something different. Sometimes it is marked, sometimes it is not. The patient totters when he closes his eyes. There is lack of proper balancing power in the system.

This symptom occurs in many cases of disease of the cerebellum, but from the fact that it does so you are not to conclude that the cerebellum is the center for equilibration.

It has been said that this organ is the center for the muscular sense, the same thing as Flourens indicated, although he did not give it a name. The guiding power is lost in these cases, and there is a state of apparent drunkenness.

The appearance of this symptom is not due to the loss of the center controlling movements, because the destruction of a great part or even the whole of the cerebellum may occur without the loss of this power. If the center for controlling movements were situated in this place, we ought always to have loss of this power when there is disease in the cerebellum, which, I have already said, is not true.

## ON A PERCOLATING AND FILTERING STAND.

By JOSEPH P. REMINGTON, Philadelphia, Pa.

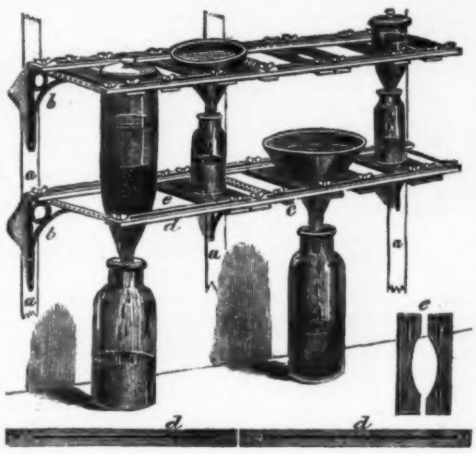
MOST pharmacists are compelled to be economical of the space in their pharmacies which has been set apart for manipulations. They require the greatest amount of room for the show-cases for displaying their wares and for the accommodation of the dispensing counter and its accessories; this is particularly the case in large cities and towns, where property is relatively high in price, when it becomes an expensive luxury to possess a well-appointed laboratory, distinct and separate from the store, where all strictly chemical and pharmaceutical processes may be conducted out of sight of the customers and free from the interruptions that become so harassing, and which, without great care, are apt to interfere so materially with the thorough performance of these duties. He who possesses plenty of room, however, and can extend at will his facilities for manufacturing, has a great advantage, in this respect, over his less fortunate neighbor.

The writer has used, with a great deal of satisfaction, for the last four years, a percolating stand, which is particularly adapted for the use of the pharmacist who has frequent demands for varying quantities of numerous galenical preparations, and who either makes them himself or prefers to have all of the operations go on immediately under his own supervision. This stand was contrived with the view of accommodating vessels of different sizes and shapes, and the excellent wood-cut which accompanies this description will almost make comment unnecessary. It may be useful, however, to give the dimensions and some explanations.

Three upright strips *a*, four and a half feet long, one and a half inches wide, and three-quarters of an inch thick, are fastened to the wall, as shown, two feet nine inches apart, over the working counter. Six iron japanned brackets *b*, 15x9, are now fastened by screws to the upright strips, three of them in the same plane, the top of the bracket eighteen inches above the level of the counter, and the other three in the same plane; the tops of these twenty-two inches above the tops of the lower set.

The longest limbs of the brackets are placed horizontally, and are perforated by drilling half-inch holes, one inch apart, along the edge of four of them (the outside edge is preferred), while two of the brackets (those designed for the middle supports *c*) should have holes drilled on both edges. Upon the brackets the horizontal strips *d* are laid; these should be of black walnut or other hard wood, and are two feet nine inches long, one inch thick, one and three-quarter inches wide; a slot half inch wide is cut into each of these horizontal strips through the middle, but not extending quite the whole length; the strip should be left solid for a distance of three inches from the ends. The cross pieces *e* are made of black walnut and are fifteen inches long, two and a half inches wide, one inch thick; a slot half inch wide is cut in the same manner in them, but it does not extend the whole length, leaving one and a half inch solid at the ends. These cross pieces should be in pairs, and seven or eight pairs should be made, varying the curves, in order to better accommodate the various shaped percolators, funnels, etc., which may be used; the sides of the curved cross strips should be beveled, for the same reason. Iron carriage bolts, ⅜ inch, three inches long, with the nut replaced by thumb-screws, are used for fastening the horizontal long strips to the brackets, and also the cross pieces to the horizontal strips; iron washers should be used with the thumb-screws to prevent injury to the wood.

It will be seen that by this contrivance the horizontal strips may be made to approach each other (by inches, if desired) by slipping out the bolts and inserting them into the different holes in the bracket, and the cross pieces may be slipped along the length of the horizontal strips at will, or




when they are needed to grasp the percolator moved to their proper position, and the percolator pushed up or down and adjusted to the proper height to suit the receiving bottle, and the thumb-screws can then be used to secure it, so that a solid, vice-like grasp prevents the percolator from tilting or getting out of position.

Funnels for filtration can, of course, be readily accommodated by the stand. If a large percolator is used, the top may be run up to what is sometimes called the "second story," and adjusted by the cross pieces in the upper tier, the receiving bottle resting on the counter. Smaller operations could be carried on on the first floor; but if there is no more room here, and it is required to conduct more processes on a smaller scale, cross pieces may be laid on the "first floor" horizontal strips and there secured, to rest the receiving bottle on. In fact, the plan may be greatly enlarged and is susceptible of indefinite multiplication; and if wall space can be spared, a third, fourth and fifth floor, or tier, may be added.

The advantages of the stand are that many operations, which would ordinarily be scattered about the working counter or carried on in different parts of the store, may all be performed in a very limited space, and hence can be watched and attended to more thoroughly. The percolators or funnels may be adjusted to a nicety, so that the beaks may extend into the receiving bottle just as far as desired, and when these are full, or require transferring, it is easily done.

There is no spilling of menstruum from tilting or liability of fracture to the apparatus, as is frequently the case where funnels are inserted into narrow-mouthed bottles and there become tightly jammed. When required, muslin strainers may be used upon it for collecting precipitates by tacking the corners of a square or oblong piece of muslin upon the horizontal strips, using a dish to collect the liquid upon the counter. It may also be used as a retort stand for holding flask, retort, or still, for recovering alcohol under certain circumstances.—*Am. Jour. Pharm.*

## CHEMICAL SOCIETY, LONDON.

*November 15, 1877.*

DR. J. H. GLADSTONE, F.R.S., President, in the Chair.

*Chemical Dynamics*, by DR. WRIGHT and MR. LUFF.—From certain theoretical considerations the authors thought it probable that the temperature at which a body A begins to act on a compound B C in accordance with the reaction A+BC=AB+C is a function of *a*, the physical condition of the substances, *b*, the heat disturbance (evolution or absorption) taking place during the change; and *c* the chemical habitudes of the bodies, possibly expressible as numerical values constant for each substance. An elaborate series of experiments has therefore been made to find out the temperatures at which the actions of carbonic oxide, hydrogen, and free amorphous carbon on oxide of iron or oxide of copper are first perceptible. Various specimens of oxides in different states of physical aggregation were prepared, in some instances by special devices, so as to obtain products free from all traces of organic matters derived from washing water, filters, etc. The temperatures at which carbonic oxide begins to act on these bodies were determined by keeping portions of them in a tube at various temperatures, passing pure carbonic oxide (carefully freed from admixed oxygen—from air) over them, and noting the temperature at which the issuing gases first rendered baryta-water turbid. The temperature of initial action of hydrogen was obtained by dissolving the substances, after exposure to its action, in hydrochloric acid, or hydrochloric acid and ferric chloride, and testing by permanganate or ferricyanide. The temperatures at which carbon begins to act were found by observing when gas began to be evolved on heating in a Sprengel vacuum, due corrections being made for small quantities of carbonic oxide and carbonic acid occluded by the carbon, and gradually given off by it during heating. Two kinds of carbon were used—one a dense sugar-charcoal, well roasted, ignited in a current of chlorine, and again heated in a closed platinum crucible till no more hydrochloric acid came off; the other, a light pulverulent carbon obtained by acting on ferric oxide with carbonic oxide at about 400° C., and dissolving out the reduced iron by hydrochloric acid. The general results of these experiments are as follows: (1) The temperature at which the action of a given reducing agent on a given metallic oxide is first perceptible depends on the physical condition of the metallic oxide, and, if carbon be the reducing agent, also on the physical condition of the carbon. (2) Hydrogen uniformly begins to act on a given oxide in a given physical state at a lower temperature than carbon, and carbonic oxide begins to act at a lower temperature than hydrogen. (3) When the physical state is about the same, a given reducing agent begins to act on copper oxide at a lower temperature than on iron oxide. (4) The two last conclusions are special cases of the general rule that *the greater the algebraic value of the heat disturbance* (*i.e.*, the more heat evolution or the less heat absorption) *the lower the temperature at which the action is first noticeable.* (This rule, is, however, not general for all metallic oxides, as it does not apply in the case of iron and tin oxides.) Thus in the case of the reactions—

$$(1)\ CuO+CO_2=Cu+CO_2,\quad (2)\ CuO+H_2=Cu+H_2O,\quad (3)\ 2CuO+C=2Cu+CO,$$

there is respectively an evolution of heat to the extent of +30·05, +19·52, and +9·48 kilogram heat units per 16 grms. of oxygen transferred from metallic oxide to reducing agent. In the corresponding actions of these agents on $Fe_2O_3$ the heat disturbances are +1·90, −8·63, and −18·67. In the reduction of cuprous oxide there is almost the same heat disturbance as in that of cupric oxide (by the same reducing agent). Hence the temperature of initial action on $Cu_2O$ of each agent lies very close to that found for CuO, in fact within the limits afforded by variations in physical state. The action of carbonic oxide on precipitated cupric oxide is noticeable at a temperature much lower than 100°; at 100° carbonic oxide is wholly converted into carbonic acid by heating it in sealed tubes with some oxide. By passing carbonic oxide over cupric oxide at 100° pyrophoric copper is soon obtained almost free from oxide. If the carbonic oxide contain a trace of air, the partially reduced oxide serves as a conveyer of oxygen to the carbonic oxide, thus producing much more carbonic acid than that due to the cupric oxide acted on. The actual temperature values obtained with chief specimens examined are given in the following table:

| Substance. | Initial Temp. of Action with— | | | |
|---|---|---|---|---|
| | CO. | H. | Sugar C. | C frm. CO. |
| Copper oxide by precipitation | 60° | 85 | 390° | 350° |
| Ditto by ignition of nitrate... | 125 | 175 | 430 | 390 |
| Ditto, prolonged heating of metal | 146 | 172 | 440 | 430 |
| Cuprous oxide | 110 | 155 | 380 | 345 |
| Ferric oxide, by calcining $FeSO_4$ | 202 | 260 | 450 | 430 |
| Ditto, precipitated | 90 | 195 | 450 | — |
| Ditto, precipitated, and gently ignited | 220 | 245 | 450 | 430 |

*On the Chemistry of Cocoa-Butter*, by MR. C. T. KINGZETT (*Part I. Two New Fatty Acids*). The specimen of cocoa-butter examined was hard, imperfectly transparent, slightly yellowish, melting at about 30° C., and when once melted remaining liquid for some time at a lower temperature: it contained no volatile or soluble fatty acids. The acids were prepared by saponifying the butter, and decomposing the soaps with dilute sulphuric or hydrochloric acid. They were purified by recrystallization from alcohol, fractionating, etc. Many analyses and melting-points of products obtained are given. The extreme acids found were represented by the formulæ $C_{12}H_{24}O_2$ and $C_{64}H_{128}O_2$. The first is the formula of lauric acid, but it melts at 57·5° (lauric acid melting at 43° C.), so it must contain some acid of a higher melting-point than lauric acid, and therefore the acid itself must be lower in the series $C_nH_{2n}O_2$ than lauric. The highest known acid in this series is melissic acid, $C_{30}H_{60}O_2$; the new acid has a formula not lower than $C_{64}H_{128}O_2$. Many salts of these acids were prepared, but details as to their composition are reserved for a future communication. The low acid crystallizes in pearly plates or fine long needles. The higher acid—for which the author proposes the name of "Theobromic Acid"—crystallizes in microscopic needles or granules, melts at 72·2° C.: at a high temperature distills apparently unchanged, and is somewhat electric when dry, a property which is possessed in a high degree by its silver salt. The total fatty acids of cocoa-butter contain about 20 per cent oleic acid. The author, in conclusion, points out that textbooks state that "cocoa-butter yields, almost exclusively, stearic acid." From the present investigations it is clear that this statement is entirely incorrect. It is based entirely on determinations of the melting-point of the fatty acids obtained.

Mr. Duffy said that from the proportion of carbon he should have expected a higher melting-point, observing that a very small quantity of a fatty acid containing a low percentage of carbon had an enormous effect on the melting-point of a high acid, perhaps from some kind of solvent action.

*On the Influence Exerted by Time and Mass in Certain Reactions in which Insoluble Salts are Produced*, by M. M. P. MUIR. In this paper the author has worked out in detail a suggestion given by Dr. Gladstone (*Chem. Soc. Journ.*, ix., 54) to the following effect:—"It is easily conceivable that, where the affinity for each other of two substances that produce an insoluble compound is very weak, the action may last some time, and become evident to our senses. Is not this actually the case when.... carbonate of soda in solution is added to chloride of calcium?" The author has taken solutions containing known quantities of calcium chloride and potassium or sodium carbonate, and allowed them to stand for a certain number of minutes after mixing, collected the precipitate formed, and thus has obtained approximate results, which are, however, strictly comparable among themselves. These results the author has represented graphically in curves. The greater portion of the chemical change takes place during the first five minutes, afterward the reaction decreases very much in rapidity. The relative masses of the salts exert an important influence. Thus if the mass of alkaline carbonate be four times that required by the equation $CaCl_2+M_2CO_3=2MCl+CaCO_3$, the action is completed in five minutes; but if the salts are mixed in equivalent quantities the action is not completed in forty-six hours. For short periods of time potassium carbonate yields more calcium carbonate than sodium carbonate. An increase of the temperature produces in every case an increase in the amount of calcium carbonate formed in a given time, while dilution causes a marked decrease. Dilution with sodium and potassium chloride solution gives a still more marked decrease. A discontinuous addition of one of the solutions to the other causes the action to reach a maximum more quickly than when the solutions are mixed at one time, but the maximum so reached is no greater than that which is finally attained under the latter conditions. In conclusion the author gives the results obtained by mixing solutions of calcium sulphate and sodium chloride, allowing them to remain for four weeks, and then estimating the calcium sulphate decomposed. When 14·2 molecules of sodium chloride were used to 1 of calcium sulphate, 32·9 per cent of the latter was decomposed. Further experiments on this subject are promised. (See Graham, *Chem. Soc. Journ.*, iii., 60). Graham has shown that sulphates of potassium and sodium are decomposed by lime-water, yielding diffusates containing caustic potash and soda respectively. The above experiments shown how the chlorides of the alkalies may yield sulphates, and these in turn may furnish the alkaline carbonates required by plants.

## DESTRUCTION OF LEATHER BY GAS.

By George E. Davis.

More than two months ago one of my clients brought me some books (cash books) which had been in daily use from 1853 to 1858 in a large office in Manchester. In the beginning of 1858 they were placed uncovered upon a shelf near the ceiling, where they remained until August, 1877. These books had been strongly bound in rough calf, and had red-basil lettering-pieces. Upon knocking the books, the leather from the backs came off as a mixture of dust and small pieces, which were very acid to test-papers.

Some of the leather carefully scraped from the back was treated with hot water, when it yielded a substance more nearly resembling India rubber than anything else I have ever seen; this, though, only when wet, for when dry the mass was very brittle and easily powdered.

The aqueous solution contained:—

| | Per cent. |
|---|---|
| Combined $SO_3$ | 2·847 |
| Free $SO_3$ | 1·020 |

The red-basil lettering-piece was next examined, and found not altered much in strength, though it had suffered somewhat. The leather on digestion with water had evidently undergone but little change, as the pieces retained their shape; the aqueous solution contained:—

| | Per cent. |
|---|---|
| Combined $SO_3$ | 0·99 |
| Free $SO_3$ | 0·87 |

The piece of leather underneath the letter-piece was next examined, as it was thought that the lettering-piece would have acted as a filter and kept back the $SO_3$ from the leather beneath it. It was very strong, though perhaps not quite as strong as new leather, and when treated with water the filtrate contained:

| | Per cent. |
|---|---|
| Combined acid | 0·39 |
| Free acid | 0·76 |

Now, knowing that all bookbinders use alum in the paste and that rough calf is tough to work, and therefore the paste is often put on in excess and allowed to soak in, it was thought advisable to examine another book in rather a different manner.

The back was scraped off and treated as before; part was boiled with soda, when it yielded 1·32 per cent. of ammonia.

| | Per cent. |
|---|---|
| Combined acid | 3·46 |
| Free acid | 2·18 |

The red-basil lettering-piece gave—

| | Per cent. |
|---|---|
| Ammonia | 1·28 |
| Combined acid | 0·87 |
| Free acid | 1·04 |

Here it will be seen that the ammonia is in excess of the acid necessary to form a sulphate; but it must be remembered that *all* lettering-pieces were in those days glaired over with "glaire," or white of egg.

A large piece was cut from the side of the book, and this side was not freely exposed to the air during the twenty years it remained on the shelf; therefore it only received the products of combustion, due to the circulation of air through the pile of books. This piece from the side gave:—

| | Per cent. |
|---|---|
| Ammonia | 0·46 |
| Combined $SO_3$ | 1·85 |
| Free $SO_3$ | 0·64 |

I am now repeating these experiments upon new leather, the results of which I will communicate when finished.—*Chemical News.*

Manchester, Oct., 1877.

## ACTION OF SULPHURIC ACID AND OXIDIZING AGENTS ON MORPHIA AND ITS SALTS.

By David Lindo.

Of the various tests for morphia, the color produced by oxidizing agents does not appear to have met with the attention it deserves. The well-known tint produced by adding nitric acid to the alkaloid or its salts is evidently the result of oxidation.

When the action of the acid is controlled in a manner to be presently described, a much deeper and more permanent red color is developed than can be obtained by applying the test in the ordinary way. Fresenius quoting from Otto makes the following reference to this modification of the nitric acid test:

"If morphia, or a compound of morphia, is treated with concentrated sulphuric acid and heat applied, a colorless solution is obtained; if, after cooling, 8 to 20 drops of sulphuric acid mixed with some nitric acid are added, and 2 or 3 drops of water, the fluid acquires a violet red coloration; gently heating promotes the reaction."

He then goes on to describe the further action produced on the addition of binoxide of manganese, or chromate of potash, either of which it is stated will develop a deep mahogany brown color in the mixture. The reaction with nitric acid and other oxidizing agents can be produced in the following simple manner:

Place a grain of morphia or any of its salts (I used the muriate in my experiments) in a small porcelain dish, and apply 20 minims in pure concentrated sulphuric acid, and apply a gentle heat for a few seconds. Let the mixture cool a little, then add cautiously 60 minims of distilled water. If a drop of this mixture is placed on a white porcelain surface and touched with a slender glass rod moistened with nitric acid, a beautiful deep red color will be developed, which remains unchanged for a considerable length of time.

The reaction is not confined to nitric acid; every oxidizing agent I have tried produces the same red color if applied to a solution of morphia in sulphuric acid prepared as above. All the following substances can be used in this way as tests for morphia: Iodic acid, ferricyanide of potassium, bichromate of potash, chlorate of potash, and most of the nitrates.

These reagents are best applied in small quantities in the solid state. Binoxide of manganese, peroxide of gold, and peroxide of lead can also be used.

It is indispensable that the concentrated sulphuric acid should be allowed to act on the morphia, or its salt (aided by a gentle heat), before water is added, for if the alkaloid or its compound is dissolved at once in dilute sulphuric acid, the reagents will produce little or no effect on the solution.

If the tests are applied to a solution of morphia (or its salt) in concentrated sulphuric acid, to which solution no water has been added, some of them will not act at all, and others will produce reactions which are very well known already. On adding iodic acid, for instance, iodine will be set free; and a green color will be developed with bichromate of potash from reduction of the chromic acid.

The smallest visible quantity of morphia or its salts in the dry state can be tested by the method I have proposed. It is merely necessary to heat the particle gently with a small drop of sulphuric acid, add 2 drops of water afterward, and apply any of the oxidizing agents named above to the solution.

I give the preference to iodic acid, ferricyanide of potassium, nitric acid, and the nitrates; when the latter are used it is sometimes necessary to apply a gentle heat.—*Chemical News.*

## LIQUEFACTION OF ACETYLEN.

By M. Cailletet.

When acetylen is compressed, its initial temperature being +18° at the pressure of 83 atmospheres, numerous drops are formed and flow along the inner sides of the tube. If the pressure is reduced some atmospheres the liquid is suddenly resolved into gas, and the tube is for a moment filled with a dense mist. Liquid acetylen is colorless and very mobile; it seems to refract light strongly; it is much lighter than water, in which it dissolves to a large extent. It dissolves paraffin and fatty matters. If liquid acetylen is cooled to zero in presence of water and linseed oil, there is formed a white, snow-like solid, which is again destroyed if gently heated, or if the pressure is reduced, with the evolution of numerous bubbles of gas. Acetylen is liquefied at the following pressures:—

| | | |
|---|---|---|
| At + 1° | 48 | atmospheres. |
| 2·5° | 50 | " |
| 10° | 63 | " |
| 18° | 83 | " |
| 25° | 94 | " |
| 31° | 103 | " |

Hydride of ethylen at +4° is liquefied at 46 atmospheres.

## ALTERATION OF EGGS.

By A. Béchamp and G. Eustache.

Hens' eggs may be preserved for a long time in a medium abounding in infusoria without these being able to traverse the shell and penetrate into the interior. But microscopic moulds can penetrate both the shell and its lining, and develop themselves in abundance on its internal surface.

## ACTION OF WATER CONTAINING CARBONIC ACID UPON CERTAIN MINERALS AND ROCKS.

By Dr. J. Muller.

The minerals and rocks examined were adular from St. Gothard, oligoklas from Ytterby, hornblende rock from Altenburg, magnetic iron ores from the Zitterthal and from the Kaschberg in Bohemia, meroxite from Hammond, in St. Lawrence County; apatite from Katharinenburg; asparagite from Chili; olivesic rock from the Ultenthal, in Tyrol; noble serpentine from Snarum. All these rocks and minerals were decomposed by water containing carbonic acid. Lime, potassa, soda, and the protoxides of iron, manganese, nickel, and cobalt were converted into carbonates. When alkaliferous silicates, such, as adular and oligoklas, were acted on, small quantities of silicic acid were dissolved, probably as hydrate. Even alumina was dissolved in a minute quantity. The reddening of felspar is the first stage of decomposition, and the formation of kaolin the second. Augmented pressure promotes the action of carbonic acid water more than increased time. The behavior of magnetic iron ore with hydrochloric acid throws no light on its decomposibility by carbonic acid water. Apatite dissolves much more readily in such water than might be expected from its appearance under the microscope.

## SODIUM SALICYLATE.

By George W. Kennedy, Ph. G.

Sodium salicylate having rapidly gained favor in my section of Pennsylvania as a remedy for rheumatism, I have been compelled to make it for the use of our practitioners. At first my method was to saturate the acid with sodium-bicarbonate at the time of dispensing the prescription. This plan was slow and unsatisfactory, and to replace it I have devised the following: Take of solution of pure white caustic soda, of 20 per cent. strength, at pleasure; saturate with salicylic acid of known purity by adding the acid until no longer dissolved; filter, and evaporate on a water-bath until, by stirring, a fine white powder is obtained.

As thus prepared, salicylate of sodium is freely soluble in glycerin, making a straw-colored solution, and in water to the amount of 50 per cent., which solution is yellowish, of a sweetish taste at first, becoming quite acrid and unpleasant after a little time. It is insoluble in the fixed oils, oil of turpentine, benzin, and bisulphide of carbon, sparingly so in ether and 95 per cent. alcohol, though more freely when hot. Its exhibition in the dose of about 30 grains daily has been attended with some quite remarkable effects in some cases of rheumatism in which other remedies have failed.

## SIMPLE MEANS OF DISINFECTION.

By A. Eckstein.

The author considers chloride of lime the most powerful agent for deodorizing privies. He proposes to use it wrapped up in parchment-paper to prolong its action. He found that the aqueous solution of 1 kilo. of copperas destroyed the odor of $H_2S$ in a privy used daily by at least 100 persons. After twelve hours the action was at an end. The action of sulphate of copper was similar. 1 kilo. of solid copperas acted for two days. 1 kilo. of a mixture of copperas and sulphate of copper with carbonate of lime acted for two days. Liquid sulphurous acid acted very rapidly: for one hour it was oppressive to breathe, and its action had disappeared after twenty-three hours. Crude carbolic acid added to the extent of 30 grms. diffused so unpleasant a smell for two days that its local action could not be observed. 1 kilo. of copperas in a bag of parchment-paper only began to act in two hours, and kept the place inodorous for three days. 1 kilo. of good chloride of lime in a similar bag acted perfectly for nine days. 60 grms. permanganate of soda acted immediately, but its effect ceased in twenty-four hours. If inclosed in parchment-paper it was efficacious for two days. Chloride of lime along with sulphuric acid is pronounced the most powerful disinfectant (deodorizer?) known.

## PHOTOGRAPHS IN NATURAL COLORS.

By Dr. H. Vogel.*

In my last communication I spoke of the remarkable so-called prismatic photographs in natural colors which Albert, of Munich, exhibited in the Nurnberg Exhibition, which have been the subject of a great deal of discussion. As I hear, the matter has already been ventilated in the general newspapers, and the statement has gone forth that photography in natural colors is already an accomplished fact. Nay, more. The public have already begun to ask for photographs in natural colors at the Berlin studios. I do not know personally what has been written on the subject, for it appeared in my absence; but as the pictures have at any rate been a good deal talked about, it will interest everybody to know something more about the prints in question. Herr Albert, during my sojourn in Munich, permitted me to see everything in the most friendly manner, plates, originals and proofs, and communicated to me sufficient of the process to permit me to form a judgment upon it.

The Albert pictures are in no way photographs of colored pictures taken direct from nature, but are simply prints in colors. If three pigments are used—red blue and yellow—upon the same ground, all sorts of tints may be secured. If red is withheld, then green is the result; if all three pigments are printed off upon one and the same spot, then a sort of black is produced; if red and blue alone are used, violet is the result. Every picture may be regarded, therefore, as the result of mixing up red, blue and yellow, colors which are used in different quantities throughout. If one will imagine for an instant a colored carpet with a ground of aniline-red, yellow border, and green flowers, you have in the aniline-red a mixture of red and blue, in the yellow, as a rule, a mixture of yellow, some red, and a little green, and in the green a mixture of yellow and blue.

A skillful printer in colors reproduces a pattern of this kind by preparing several stones. Upon one he merely sketches the green flowers, on another only the aniline ground, and on the third only the yellow border. All three stones are then printed off upon the same paper, and yield a chromo-lithograph. It is exactly in this way that Obernetter does his work; only instead of stones he employs for his work Lichtdruck plates, and instead of sketching he prints off portions of a negative in certain tints.

Albert proceeds in this manner—he prints with three different Lichtdruck plates the three colors, red, yellow, and blue, one upon the other. He produces his three-color plates in a very original manner. The process comes originally from that of M. Ducos du Hauron, who, three years ago, essayed to prepare colored pictures by taking three negatives, secured respectively through red, green, and violet glass. In the negative taken through red glass the red light was supposed to be strongest; but, unfortunately, as we know, red light is very inactinic. By making use of my discovery, however, Ducos was enabled, by the aid of tinted collodion, to secure three suitable negatives.

Albert proceeds in a similar manner. He produces three negatives, the first with a collodion which is sensitive for all tints with the exception of red;—this subsequently produces a Lichtdruck plate for red. A second negative is secured with a collodion which is sensitive to all colors excepting yellow; and the result is a Lichtdruck plate for yellow. Finally, a third negative is secured, on which all colors excepting blue act; and from this a Lichtdruck plate for blue is secured.

Photographers will probably remark, in regard to the last, that such is an impossibility—that there is no plate or collodion which is insensitive to blue. To a certain extent they are right, but Albert helps himself in this way. He takes his picture through colored glass—a yellow glass put before the lens, for instance—cuts off the blue rays, and allows all others to go through, and it is then merely a question of making the collodion sensitive for all other colors—red, yellow, and green. This is done, as I have shown, by the addition of certain well-chosen substances. Thus, aldehyde green renders collodion sensitive to red rays, aniline-red makes it sensitive to yellow, and eosine to green. Of course, the manipulation of these pigments in collodion is by no means easy; they ruin the dipping-bath, and the plates require long exposures, while other defects crop up. That the problem may be practically solved, however, Albert has shown us; he has produced negatives of colored patterns in which the blue is the most transparent, and upon which, moreover, no traces of the retouching brush or pencil are to be seen.

Next comes the question as to the nature of the pigments to be employed in printing. There are, for instance, a hundred sorts of blue by means of which blue prints can be obtained, and the same may be said of blue and yellow. Which shall be taken? That which approaches most nearly to the original, is naturally the answer. And so it happens. The printer chooses the color to the best of his ability, and thus produces the nearest approach to the original; but he is not employing natural colors. The natural color of the original has, it is true, contributed to the production of the negatives; but it has nothing to do with the printing from the Lichtdruck plates. This is an operation entirely independent from the rest, and if the copies are like the original this is due to the skill of the printer in matching the colors; the finished tint is more or less like nature, but nature has had nothing to do with their application. So much must be said on the score of truth, although I do not wish to detract one jot from Albert's very difficult and interesting *modus operandi.*

Among the impurities recently detected in the waters of the Rhine by Dr. Vohl, of Cologne, are large quantities of arsenious and phosphoric acids. The latter is a valuable fertilizer, and its removal to the sea in this manner is detrimental to the German soil. The arsenious acid is supposed to come from the dyeing establishments in the Rhine Valley.

A careful series of experiments by Professor J. Plateau, of Ghent, indicates that insects are never so far deceived by artificial flowers as to alight upon them in search of food. It is probable, however, that the bright colors of such flowers serve to attract insects from a distance into their neighborhood.

*Photographische Notizen.

## CACAO CULTIVATION IN CEYLON.

CEYLON, which has long been famous for its coffee, will, in time, have a name also as a producer of tea and cacao. Neither need dispute the territory of the other, for tea touches coffee at its highest elevations, while cacao but reaches its very lowest. Cacao cultivation has only begun in Ceylon, but it gives a promise of doing so well that, ere many years are past, acres of land which are at present too low for coffee (*Caffea Arabica*), or the cultivation of which is rendered extremely precarious, owing to climatic influences, will have the cacao tree taking its place. A spirited experiment is, at present, being tried on an estate in Dumbera, near Kandy, a rich broad valley, intersected by a river, and bounded by high ranges of hills, where the soil is fertile, and its only drawback is its liability to drought. In the hot days of the year it is bathed in sunshine, and over its bright grass fields and wooded undulations there ever hangs that deep blue haze, which is a painter's torment to render faithfully, while in showery weather the morning sun rises on a billowy sea of mist, which ere long ascends, and, floating away on the wings of the passing wind, reveals the Dumbera valley flooded with light, and as verdant and beautiful as ever. In this valley coffee has been planted, and when the rain is abundant, the crops are enormous; but generally the rain is disappointing, and the want of it sickens the heart with hope deferred, for even the coffee which may come at such a season is, as a rule, both inferior and light. The valley is not more than 1,550 feet above the sea, and this quite brings it within the range of cacao, which thrives well from the sea-level to 2,000 feet. Certainly the vigor and fertility of the cacao growing there are wonderful, and already a handsome return is coming in from the sale of the pods, which are in considerable demand for seed, and are readily sold for a quarter of a rupee each. Trees of five years old have an average of twenty-five pods, and older trees run up to over two hundred. The best authorities on cacao say that "generally only a single fruit is matured from each cluster of flowers," but on Pallakelly estate, in very many cases, the pods cluster together like coffee berries, and hang in bunches rather than singly. This was so on old as well as young trees, and some that had been manured, and were the pride of the Superintendent, had their stems and branches full of the purplish yellow fruit, while the insignificant sprig of a blossom was coming out everywhere.

For the successful cultivation of cacao it is said that "a rich, well-watered soil and a humid atmosphere, with freedom from cold winds and protection from violent storms are necessary." Dumbera, which at present has more acres under cacao than any other district in Ceylon, can hardly be described as having a "well-watered soil and a humid atmosphere." The soil, doubtless, is a very rich one, but, as I have said above, the valley is very liable to drought, and yet the tree thrives well, and does not seem to be injured by the coffee among which it has been planted, nor to injure it in return. The plants are reared in a nursery, and, when between a foot and a foot and a half high, should be planted out with great care, as they are extremely delicate. For a time they want shade, and in the West Indies it is customary to protect them by having quick growing food plants among the young trees. At four or five years old the tree begins to bear, but it has not reached its full maturity until the eighth year, after which it may go on producing for half a century.

When the fruit is ripening, the gatherers, who are armed with a stick having two prongs or a knife at the extremity, cut down the matured pods without injury to the others, which are allowed to remain until they fully ripen. The pods are then heaped on the ground for twenty-four hours, after which they are cut open and the seeds taken out, and piled to allow them to ferment. During fermentation great care has to be taken to prevent the heat from rising too high, and to avoid this the seeds should be occasionally stirred. As the quality of the cacao is very much determined by the degree of fermentation it has been subjected to, the process requires both experience and watchfulness from the grower. The length of time required for fermentation depends somewhat on the weather, but the best results are got when it has been successfully accomplished in two days. Another plan for removing the acid juice is termed "claying," from the fact that the seeds are buried in the earth instead of being heaped as described above. As a last process the beans are dried in the sun, and if they are of fine quality, they should have "a warm reddish tint."

At the beginning of the 18th century, coffee, cacao, and tea were introduced almost simultaneously to England, and they stand alone in the order of precedence. How the first and the last have taken root need not be dwelt on, and although cacao is far behind in the race (in Spain it is very largely used), the following table of the quantities entered for home consumption, which does not include what is imported in a manufactured shape from France, shows that within the last few years its popularity has been increasing:

| | lbs. |
|---|---|
| 1820 | 267,321 |
| 1830 | 425,382 |
| 1840 | 2,645,470 |
| 1850 | 3,080,641 |
| 1860 | 4,583,125 |
| 1870 | 6,943,102 |
| 1874 | 8,863,646 |
| 1875 | 9,973,926 |

Linnæus thought so highly of cacao that he called the genus *Theobroma*, from two Greek words, meaning a food fit for gods. Unlike tea or coffee, nothing of it is wasted, and so great an authority on foods as the late Dr. Edward Smith describes its action as "less exciting to the nervous system than tea or coffee, and at the same time it contains a much greater proportion of nutritive materials."

The future of cacao in Ceylon is of course unknown, but, judging from its opening promise, there is good reason for believing much, while hoping more. In the markets of the West such a thing as a Ceylon brand for this produce is altogether unknown, but doubtless ere long it will find its way there, and let us hope compete successfully with the red nuts of Trinidad or the far-famed cacao of Caracas. Are there not districts in Southern India in which the enterprise of the Dumbera Planter can be imitated?—*Madras Times.*

---

A frozen plant may frequently be preserved if plentifully drenched with cold water, because the application of that liquid produces a natural thaw, whereas the sudden elevation of temperature which would be occasioned by the morning sunbeams, or by water warmed thereby, would be fatal to the plant.

## HORTICULTURAL NOTES.

PRUNING NEWLY-SET TREES.—It has long since become well established that a reduction of the heads or foliage of transplanted trees has contributed to their vigor and successful growth. Many are not aware of the necessity of this practice, and do not know what portion of the entire amount of root is left behind in the ground when the tree is lifted from the soil, even when the work is carefully performed. We repeat a diagram (Fig. 1), which we have exhibited on a former occasion, to show the network of roots beneath the soil, extending usually as far each way from the foot of the stem as the height of the tree. In the nursery the fibres cover the whole surface between the rows (Fig. 2). Now, in taking up a tree, the circle of roots cut and lifted, shown by all within the circular line in Fig. 1, is necessarily but a small portion of the whole mass, and, when reset, it is absolutely necessary to reduce the weight of the top to some extent. This reduction should not be as great as the reduction in the roots, for it is important to retain as many leaves to manufacture growth with as can be done without detriment. The practical question arises, to what extent should this reduction be made?

As a general rule, it should be about one-half to one-quarter as much as the loss of the roots, as nearly as can be determined by careful examination and estimate. It must vary with the kind of tree. The peach will bear a very free pruning, and will readily throw out new shoots. The cherry has far less of this reproducing power. The peach should therefore be more freely pruned than the cherry. The apple and pear are intermediate between them. Peach trees are usually transplanted when one year from the bud—more rarely at two years. But we have found no difficulty in removing such as are four or five years old (provided the roots have been cut back a year or two previously), if severely pruned at the time of setting out. As already remarked, the cherry will bear less pruning than most other kinds, but we have found, in removing two-year trees, that, by partly cutting back the young shoots, they would make a growth the same year four or five times as great as with pruning omitted.

two years, and if the land is not naturally fertile, give a light top-dressing of manure the year when not plowed. It is more important, in cultivating the ground, to stir the surface midway between the trees, than immediately under the large branches. Where grass is cropped short, as by sheep, the roots do not run so deep nor draw hard on the soil; and the droppings of the sheep serve as a top-dressing. Where the animals cannot be admitted, or where a perfect finish is desired for the appearance of the orchard, the grass may be kept short and smooth by the hand or horse lawn mower, and a top-dressing of manure, ashes, or compost given in autumn, as the soil may require.—*Country Gentleman.*

## GOVERNMENT GARDEN, OOTACAMUND, INDIA.

FIFTY-TWO acres, having a southern slope, are under the care of a gentleman of special ability as a floriculturist and arboriculturist. This English official receives his salary from Government, as do the Assistant Superintendent, gardener, propagator, student, writer—the expenses of these subordinates amounting to eighty rupees a month. All other working costs are met by the sale of seeds and bulbs, which realize three hundred rupees a month, and are sent all over the country, such heights as those of Bangalore especially patronizing them.

The garden faces the south, and the roadway passes between the beautiful little building used as seed offices, made of bricks painted white, except here and there are black bricks for the sake of effect; the roof is metallic, the chimneys suggest a cold place, and there are ornamental finials. Beyond the entrance the road becomes two arms, one reaching to the north on the east and the other on the west side of the grounds, and pointing to the higher terraces reached by a long gradient. On the east side of the garden is a grove of the tall and beautiful Eucalyptus, which is larger and more fair at the same age than these trees growing at a lower level in the hills, greater cold being favorable to it. This wall of trees is a splendid barricade. In the front center of the grounds, in the sward studded with various trees, largely evergreen, we enter the hot-house, having a glass roof

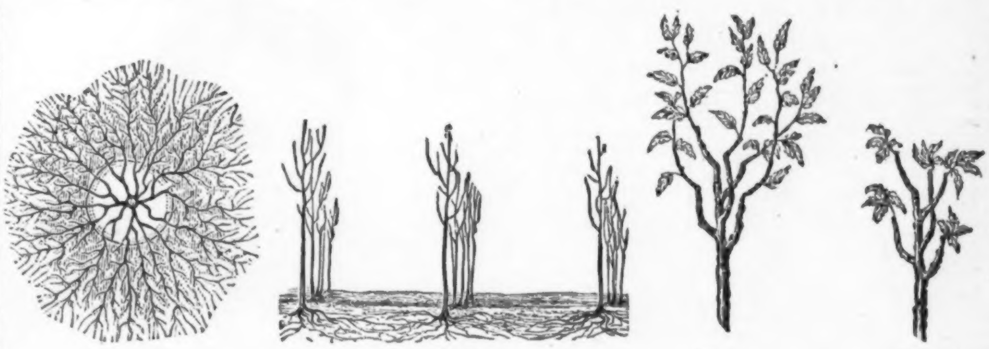


FIG. 1. FIG. 2. FIG. 3. FIG. 4.

PROPER METHOD OF PRUNING NEWLY SET FRUIT TREES.

The inquiry is often made by novices, how the cutting back is to be performed—"we want specific directions." These are easily given. First, cut entirely away any twigs, shoots, or limbs which give the tree a bad shape, and bring it into proper form. It may happen that little or nothing is required in this way. Then cut back one-half or two-thirds, or in extreme cases nine-tenths of all the previous season's growth or one-year's shoots. This is the whole process. It has the special advantage of not diminishing the actual size of the head or changing its form, at the same it has to sustain only half, or one-third, or one-tenth the number of leaves that would be held without the pruning; and those that remain can then be fed and sustained from the roots, and they will be fully developed and impart vigor to the tree. No one will hesitate as to the utility of the practice, if he has tried the experiment of pruning side by side, or in alternate rows—by pruning a portion and leaving another portion with full heads.

It must always be borne in mind that the pruning is to be done before the buds begin to open in spring. Nothing checks a young newly-set tree more than cutting off a part of the foliage after it has partly or wholly expanded. The two figures here given are a moderate and fair representation of the effects of pruning before and after the buds open—Fig. 3 showing the shoots grown a foot or two in length from early pruning, and Fig. 4 with shoots an inch long, checked by late cutting.

Inquiry is also made whether the cutting should be done in autumn or spring on trees transplanted in autumn. The answer must be conditional. Trees that are entirely hardy, and when there is no danger of any injury from the severity of winter, may be pruned now, the reduction of the top partly preventing the trees being bent about by winds. With tenderer trees, the tops should be undisturbed till early spring, as pruning makes them more susceptible of injury by cold, and they should be secured against wind by stakes, or by mounds of compact earth about the stems.

---

NEW VEGETABLES.—A writer in the *Rural Home* gives the results of his experiments with new vegetables. He thinks the Black Mexican the best of all varieties of the sweet corn, without exception. Butman and Yokohama squashes were poor bearers; Moon's Vegetable Cream yielded profusely of a very poor squash, and he goes back to the old Hubbard. The Japan pea bore poorly of a very poor pea. Hanson lettuce was excellent. Lang's Improved (Swede) turnip yielded a large crop of large, handsome turnips, excellent for feeding animals, but not so good as the Stone turnip for the table. The best tomato he tried was the Golden Trophy. The Hardy Ridge melon bore a small crop of poor melons; Casaba and Sill's Hybrid he likes best of all, and Green citron next. Blue Imperial he finds to be an excellent pea. Laxton's Alpha is one of the earliest and best.

---

ORCHARD CULTURE.—The treatment recommended by J. C. Plumb, of Wisconsin, and found by him most successful on his own ground, is approved by many good cultivators elsewhere, and is in substance as follows: Cultivate well when the trees are young, during the early part of the season, omitting it later, to promote cessation of growth and ripening of wood. When the trees reach full bearing, seed to clover, turning under the second crop as a fertilizer, every

as its only means of heat. The foliage is varied. The most beautiful thing there now is the Camellia, to which flower, native of China and Japan, a Jesuit Camelli, who took it West, is said to have given the name. The plant, eight feet high, like an olive, has some few dozens of flowers and buds. The flower is large and white, with varied red, and is called variegated. A plant is sold for eight annas; a flower for four annas, and it will last a week.

Passing upward, we see the cone-bearing trees, the ponds having hundreds of lilies of most pure white, with golden post within, having at its base nails of gold. In clumps there is the lily's companion, a rough grass having large white top. At a high terrace, overlooking the garden to the south, we sit in the round house of rest for the visitor. It has a diameter of thirty feet, and is surrounded by vines loaded with blossoms. Here is the strange and wonderful passion flower, with its central three nails, then the five wounds, then the surrounding twelve apostles, and also the crown of thorns. On each side of the temporary home there is a score of beds of flowers, in front is a pond favored with lilies, and behind are three low terraces of flowers. We weave a wandering path through these beds of verbena, geranium, fuchsia, marigold, mignonette, pansies of satin and gold or jet black or blue or yellow, Christmas flower, daisies, rose trees, ribbon grass, and a vast number of more rare flowers whose Latin names would burden these columns. Here are parterres having rings of colors, red, yellow, gray, white, in parallel masses of flowers.

We go onward and upward, among evergreen trees which Nature has cut out as gracefully as Paris shears could make them, having a branch width of two feet near the ground, then swelling to a five feet diameter at mid height, and contracting to a point at the top. Here is the Cashmere cedar, with strong trunk and numerous thin, straight limbs twenty feet long.

At a higher terrace on the right we find another fair pond giving life to lilies, the bell flower twenty feet high, having a white bell six inches in length, the dahlias, and wonderful masses of splendid rhododendrons.

We go to the furthest northeast terrace, and walk among a score of beds having green rounded top or parti-colored surface; we see the red camellia, and the air plant which can grow when hanging by a thread in the house.

The west side of the garden is somewhat similar to that which we have briefly described in the journey which we have taken to successive heights. Far back a new hot-house, in cross form, is being erected. The residence of the gentleman having the garden under his skilled care is at the left center, beautiful for situation, the lines having fallen to it in a pleasant place. A short call upon him was rewarded with kind explanations, and a bestowal of a larger quantity of Latin names of flower and plant than we shall be able to suggest here. We are determined to keep them to ourself, that is, if we can remember what they were. But no array of names shall keep us from enjoying their beauty and perfume just as much as though their labels were in the simple English of our childhood's fair home. This garden is "a thing of beauty," a rest to fatigued minds, a joy to the soul. Infinite skill and taste are exhibited here. We wonder and wander, and wander and wonder. The heart takes up a song of adoration, and thinks of the possible gardens of which this one is suggestive.—*Madras Times.*

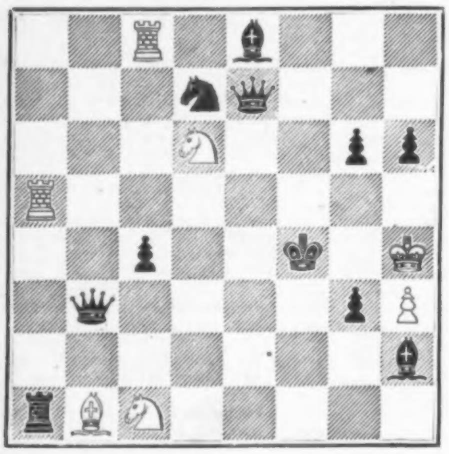
## SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department, may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 50. BY T. M. BROWN.

*Clipper* Tournament.

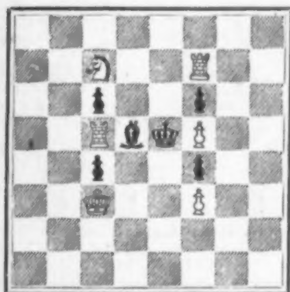
Black.



White.

White to play and self-mate in four moves.

### MAX PEILER, OF HARTFORD, CONN.



White to play and mate in 5 moves.
H. F. L. MEYER.

HAVING given a complete record of the Hartford *Globe* Problem Tourney, as well as the recent liberal programme issued by that enterprising paper, we take this favorable opportunity of introducing to our readers the present chess editor, who, in connection with his former associate, Mr. Kunkle, edits one of the most sprightly, we had almost said reckless, chess columns that our country can boast.

Mr. Peiler is a chess enthusiast, and a liberal patron of the game; although he lays no claim to proficiency either as a player or problemist, yet he takes great interest in both branches, and has strong convictions and opinions of his own, which he freely ventilates in opposition to both Hoyle and Gunter.

Mr. Kunkle has commenced a chess department in the *Forest and Stream*, where he will continue the publication of his second problem tournament, so auspiciously commenced in the *Globe*, and which is still open for competition.

### THE CLIPPER SUI-MATE TOURNEY.

THIS problematical contest was inaugurated by the indefatigable "Miron," May 11, 1867.

Two prizes were offered for the best set of two self-mates, in one of which white was to play and self-mate, in the other black to play and self-mate. Competitors allowed to enter four problems.

The award was made by Messrs. Eugene B. Cook and C. C. Barnes, Nov. 21, 1868.

There were twenty-six problems received, among which there was but one correct set, which necessarily received the first prize, no one being entitled to the second prize.

We present the winning problems, which were entered by T. M. Brown, under the motto "Par Nobile Fratrum," but are not surprised at the ill success of the tournament, as but little interest is taken in such conditional stratagems except by the authors.

As several correspondents have asked an explanation of the terms of a self-mate, we will explain that the white undertakes to compel the black to win in a certain number of moves. It is an absurdity, however, and conflicts with the established rules of the game. Few games are ever played to the final mate; the losing player has the right to resign, and does so the moment he finds his game irretrievably lost. In a self-mate, therefore, the defense has a full right to resign and defeat the proposed suicide. All such monstrosities, therefore, are faulty unless it is distinctly stated that white agrees to commit *hari-kari* in four moves, conditionally upon black not resigning in disgust.

WE notice the following answer to a correspondent in a recent number of the *London Field*. From the initials we are led to suppose it is addressed to F. C. Collins, whose liberal-spirited letter appeared in our issue of last week:

"F. C. C.—We consider the recently established British Chess Problem Association an institution deserving the widest support. The only amendment that we would propose to their programme would be that their competitions should not be exclusively national, and that the cosmopolitan character of our pastime should be acknowledged at least by occasional tourneys open to all the world. Similar societies in America and Germany place no national restriction on the participation in their competitions."

In this country a special effort is made to encourage foreign competition, and nothing has done more toward advancing the standard of problem-composing than the beautiful stratagems that have been received from abroad.

Any American tournament that debarred foreign competition would receive no encouragement from our native composers. It was attempted once, and but one competitor could be induced to enter.

### EARLY CHESS BY CORRESPONDENCE.

IN the latter part of the year 1840, when the chess-players of this city used to meet at Bassford's billiard-rooms in Fulton street, a match of two games to be played simultaneously by correspondence was arranged between New York and Norfolk, Va., for a prize of a set of chess men.

The players on the part of New York were Col C. D. Mead and Mr. James Thompson, two players who have been intimately associated with New York chess for nearly half a century, and whose names are as familiar as household words.

Norfolk was represented by Messrs. Newton, Meyers, Littleton, and Geo. Tazwell. One game resulted in a draw; the other, which we give, decided the victory for New York, both games being concluded during the year 1842.

SIR CHARLES BLOUNT, afterward Earl of Devonshire, having distinguished himself at a tilt, Her Majesty Queen Elizabeth sent him a chess queen of gold, enameled, which he tied upon his arm with a crimson ribbon. Essex, perceiving it, said with affected scorn:

"Now, I perceive, every fool must have a favor!"

On this, Sir Charles challenged and fought him in Marylebone Park, disarmed and wounded him in the thigh. The Queen used frequently to reward her courtiers by similar presents. We would suggest that her stock of chess men were exhausted when she gave her noble Essex the box (on the ears).

MAX PEILER, OF HARTFORD, CONN.

### NORFOLK VS. NEW YORK, 1840.

| NORFOLK. WHITE. | NEW YORK. BLACK. |
|---|---|
| 1. P to K 4 | 1. P to K 4 |
| 2. K B to Q B 4 | 2. K B to Q B 4 |
| 3. P to Q B 3 | 3. Q to K Kt 4 |
| 4. Q to K B 3 | 4. Q to K Kt 3 |
| 5. K Kt to K 2 | 5. P to Q 3 |
| 6. P to Q 4 | 6. K B to Q Kt 3 |
| 7. Castles. | 7. K Kt to B 3 |
| 8. P x P | 8. P x P |
| 9. K Kt to Kt 3 | 9. Q B to K Kt 5 |
| 10. Q to Q 3 | 10. Q Kt to Q 2 |
| 11. P to Q Kt 4 | 11. K Kt to R 4 |
| 12. Q B to K 3 | 12. Castles Q R |
| 13. Kt x Kt | 13. B x Kt |
| 14. Kt to Q 2 | 14. Kt to K B 3 |
| 15. Q to Q B 2 | 15. R x Kt |
| 16. Q x R | 16. Kt x P |
| 17. Q to Q B sq | 17. B to K B 6 |
| 18. P to K Kt 3 | 18. P to K R 4 |
| 19. K B to Q 5 | 19. P to K R 5 |
| 20. B x Kt | 20. Q x B |
| 21. B x B | 21. Q to K Kt 5 |
| 22. Q to K 3 | 22. R P x B |
| 23. K R to Q Kt sq | 23. P to K 5 |
| 24. Q to K sq | 24. P to K B 4 |
| 25. R to Kt 2 | 25. P to K B 5 |
| 26. Q R to Q Kt sq, and New York mates in four moves. | |

WE find the following historical incident concerning Her Majesty and Sir Walter Raleigh related in "Kenilworth." The scene is so familiar that it needs no explanation.

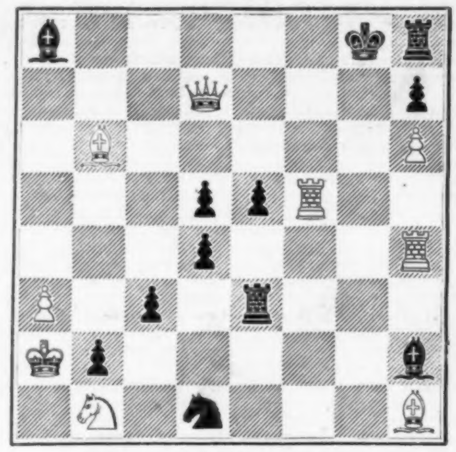
"So, hark ye, Master Raleigh, see thou fail not to wear thy muddy cloak in token of penitence till our pleasure be farther known. And here," she added, giving him a jewel of gold in the form of a chess man, "I give thee this to wear at the collar."

No wonder that Raleigh became such an ardent chess player. "I wish to live no longer than I can play at chess," he once said.

PROBLEM No. 51. BY T. M. BROWN.

*Clipper* Tournament.

Black.



Black.

White to play and self-mate in five moves.

### SOLUTIONS TO PROBLEMS.

No. 44.—BY BEN. S. WASH.

| WHITE. | BLACK. |
|---|---|
| 1. B to K 3 | 1. B x Kt |
| 2. Kt x B mate | |
| | 1. P x Kt |
| 2. B to Q B 5 mate | |
| | 1. Kt to Q 5 |
| 2. Kt to B 3 mate | |

No. 45.—BY S. LOYD.

| WHITE. | BLACK. |
|---|---|
| 1. B to Q R 4 | 1. B to Q Kt sq or Kt to Kt 3 |
| 2. Kt to Q 4 | 2. Any move |
| 3. Mates | |
| | 1. B to Kt 3 or B 2, or Kt to B |
| 2. Kt to Q 6 | 2. Any move |
| 3. Kt mates | |
| | 1. R to R 8 |
| 2. Kt to Kt 6 ch | 2. K to Q 4 |
| 3. Kt to B 7 mate | |

LETTER "M."—BY DR. C. C. MOORE.

| WHITE. | BLACK. |
|---|---|
| 1. Kt to Q 4 | 1. Q to K 4 |
| 2. R to Kt 4 ch | 2. Q to B 5 |
| 3. P x Q dis mate | |
| | 1. Q checks |
| 2. K x Q | 2. P to R 7 |
| 3. R to K 5 mate | |
| | 1. Q to Kt 6 |
| 2. R to K 5 ch | 2. Q to K 4 |
| 3. P to B 6 dis. mate | |
| | 1. Q to Q 3 |
| 2. R x Q | 2. K to K 4 |
| 3. R mates | |

IN an old number of the *Dutch Spectator* is an allegorical sketch, describing the Palace of Caprice or Folly; it gives the following description of chess players:

"I placed myself near several people, who were busy by pairs in moving with much circumspection several different little images of wood and ivory, which were placed in a certain order, like two armies opposite to each other, and were endeavoring, with great care and attention, to gain advantages. Many prisoners were taken by each party, and when this happened, the loser appeared to be so vexed as to bite his lips, stamp his feet, and cast his eyes up to heaven, as if he wanted heaven to witness his misfortune.

"One would have thought that from the loss or gain of the battle their welfare, honor, health and even life, depended. What a surprising and sudden alteration from exultation to despondency did I not witness in the same person. Now they appeared to fear, and now to hate their antagonist, then to despise and love them; and often when one of them had apparently obtained an advantage and was already triumphing with haughtiness, I saw him suddenly drawn into a scrape, and lose more than the advantage he had supposed he had gained, and then he appeared to be stunned by such an unforeseen accident. The most remarkable circumstance was, that the conqueror fed his pride with conceding that the victory was to be ascribed solely to his superior ingenuity and skill; whereas, on the contrary, the loser, after having for some time lamented his defeat, endeavors to comfort himself by laying the blame on some exterior circumstance. One said that his eyes failed him, so had not been able to see with his wonted accuracy. Another that he sat not in such a favorable light as his adversary did. A third excused himself by saying that he had always been accustomed to command the black army, and not the white; and a fourth could only say that a few words spoken during the battle had taken off his attention, or that an indifferent bystander had looked too earnestly at the combat. I, who find no follies more despicable than those which are attended with gravity, the proper attendant of wisdom, left them and joined another set of people, among whom I was in hopes of finding pleasanter follies."

THE umpire in the *Danbury News* Tournament has just awarded both prizes to Mr. C. A. Gilberg.